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BASIC WATER MONITORING PROGRAM
FISH TISSUE AND SEDIMENT SAMPLING
FOR 1984

by

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

During 1984 the Washington State Department of Ecology collected fish and sediment samples at ten locations in Washington as part of its Basic Water Monitoring Program (BWMP). Fish tissue samples were analyzed for BWMP parameters which included organic pesticides, PCBs, and heavy metals. Sediments were analyzed for priority pollutants excluding volatile organics. The analytical results for each sampling site exhibited a distinctive array of pollutants, usually at low concentrations. Elevated levels of DDT and its metabolites were generally observed in river systems in the central region of the state. The highest level of pollutants was observed at Northport on the Columbia River. At this site, heavy metals in edible fish tissue approached an unofficial Federal Drug Administration (FDA) guideline. The 1984 results and data from the 1978-1983 period of record were also used to make recommendations for future BWMP surveys.

INTRODUCTION

As part of its Basic Water Monitoring Program (BWMP), the Washington State Department of Ecology (Ecology) each year since 1978 has collected fish at selected sites throughout the state. Fish tissues are analyzed to obtain information on the incidence and distribution of metals and synthetic organic compounds in the aquatic environment. Fish not only provide a direct measurement of biologically available pollutants, but also provide a time-averaged indication of this availability. The data collected is used to identify potential problem areas requiring further investigation. In addition, the data will be used along with other information to evaluate long-term water quality changes on a statewide basis.

The 1984 BWMP effort was the first year that stream sediments were sampled at each station where fish were collected. This part of the program was made possible by a grant from the Environmental Protection Agency (EPA) Region X, Seattle, Washington.

BWMP data collected during 1984 are presented in this report. Also included for reference are the BWMP data for the 1978 - 1983 period of record (Appendix I). Recommendations concerning the future of the BWMP program in Washington State are made based on the information for these two periods of record.

MATERIALS AND METHODS

General

Twelve stations were selected for sampling in 1984 based on an assessment of the 1983 BWMP results (Hopkins, 1984) and a review of Ecology program needs:

	Station Name	Ecology Station Number
1.	Wenatchee River at Wenatchee	45A070
2.	Lake Chelan at Outlet	47A070
3.	Okanogan River near Malott	49A070
4.	Columbia River at Northport	61A070
5.	Palouse River at Hooper	34A070
6.	Walla Walla River below Warm Springs	32A070
7.	Yakima River below Kiona	37A090
8.	Yakima River at Birchfield Drain	37A195
9.	Skagit River near Mount Vernon	37A060
10.	Green/Duwamish River above Allentown	09A060
11.	Queets River near Clearwater*	21A080
12.	Crab Creek at Beverly*	41A070

The survey team was not able to capture any fish at two sites (*) because of high/low flow, inaccessibilty, or other conditions. An attempt was made to substitute the Deschutes and Satsop Rivers later in the year, but high flows precluded this effort. The locations of the ten stations where fish were obtained are shown in Figure 1. Detailed station descriptions are given in Appendix II.

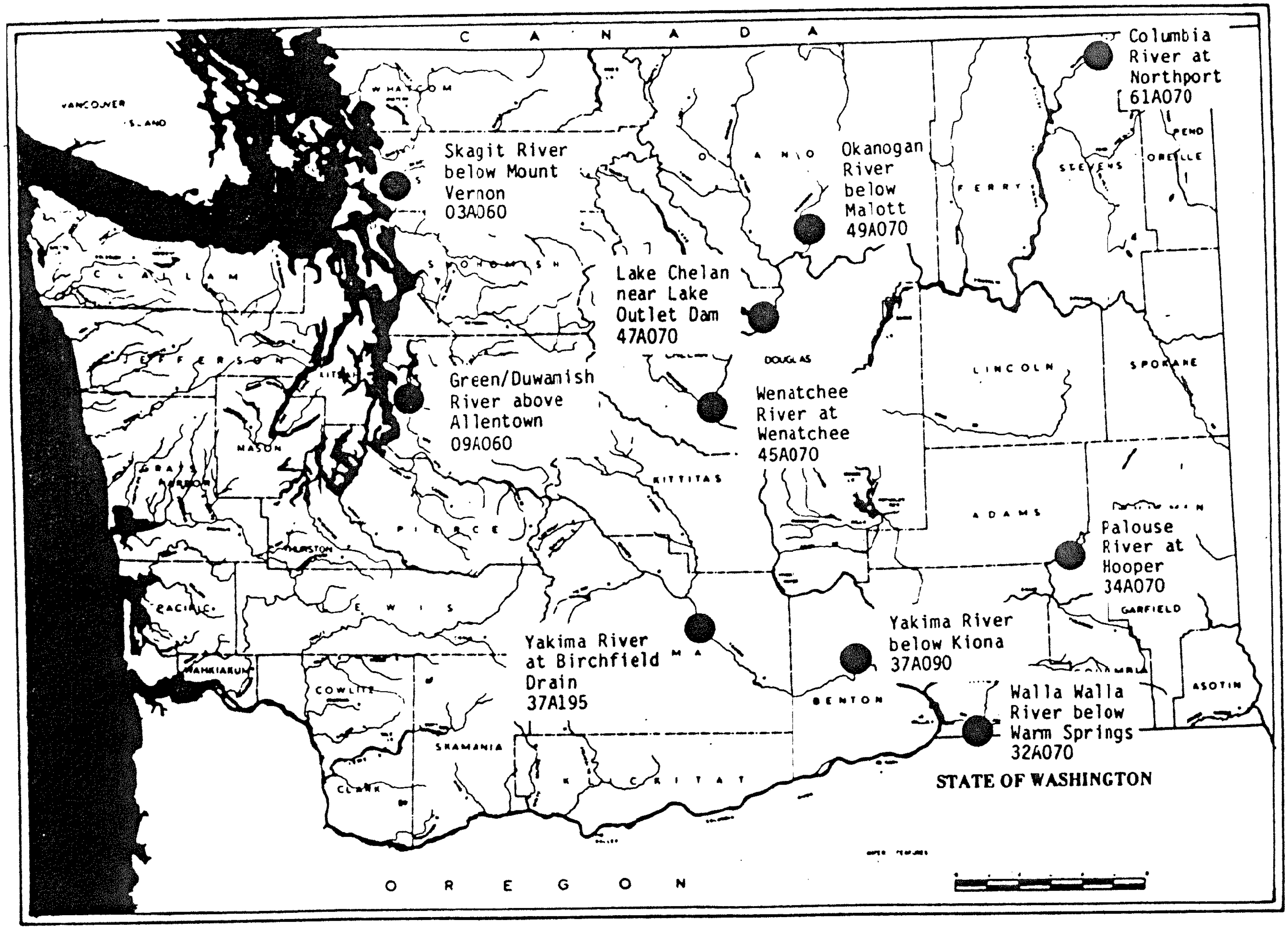

Figure 1. Sample locations for the 1984 BWMP sampling program in Washington State.

At each station an attempt was made to collect species of fish representing two trophic levels, a grazer and higher order predator. The same species were collected at each location when possible to provide comparability. Six species were collected overall:

Bridgelip sucker (Catostomus columbianus) - grazer
Longnose sucker (Catostomus catostomus) - grazer
Mountain sucker (Catostomus platyrhynchus) - grazer
Mountain whitefish (Prosopium williamsoni) - predator
Northern squawfish (Ptychocheilus oregonensis) - predator
Largemouth bass (Micropterus salmoides) - predator

Bridgelip suckers and northern squawfish were the predominant species collected. A salmonid (trout) would have been preferred as the predatory species, but none was captured.

In conjunction with the fish sampling, bottom sediments were collected from the stream channel at each station. Sample collection and handling procedures used during the survey are summarized in Figure 2.

Three tissue types from each fish composite; liver, gill, and edible fillet (fillet with skin intact) were isolated and analyzed for BWMP parameters (Table 1). Liver analyses are considered to be a good indicator of the condition of the fish. Edible fillet results can be related to FDA action levels for human health. Gill tissue (metals only) was analyzed for comparison with historical data.

Where possible, bottom sediments were collected (five sites) near each fish collection station and composited into a single sample for analysis. The sediment samples were analyzed for BWMP parameters (Table 1). Total organic carbon and grain size distribution also were measured.

Detailed information on sample collection, handling, and analytical procedures is considered particularly important when reviewing the findings of investigations which address metals and synthetic organic pollutants. For this reason, detailed descriptions of the methods employed during this effort are given in the sections that follow.

Sample Collection

The primary collection method used to obtain fish samples throughout this program was electroshocking; however, hook-and-line was used whenever the sample area was not conducive to electrofishing.

The electroshocking equipment included a Model SR-16 Smith-Root electroshocking-equipped jet sled and a Type VII Smith-Root backpack unit. Upon reaching the sample location, the electroshocker was adjusted to the proper voltage for the water conditions, and sampling commenced. Once stunned, the fish were dip-netted and placed in a stainless steel live tank when shocking from the boat, or a water-filled plastic bucket when backpack shocking. After a sufficient number of specimens were collected or a predetermined time limit elapsed, sampling was terminated.

Table 1. BWMP parameters analyzed for during the 1984 BWMP sampling program in Washington State.

Pesticides (sed. and fish tissue)
- aldrin
- dieldrin
- chlordane
- methoxychlor
- DDT forms
- alpha-BHC
- PCB
- PCP

Metals
- arsenic
- cadmium
- copper
- chromium
- mercury
- lead
- zinc

Acid Compounds (sediment)
- 2,4,6-trichlorophenol
- p-chloro-m-cresol
- 2-chlorophenol
- 2,4-dichlorophenol
- 2,4-dimethylphenol
- 2-nitrophenol
- 4-nitrophenol
- 2,4-dinitrophenol
- 4,6-dinitro-o-cresol
- pentachlorophenol

Non-Priority Pollutants (sediment)
- benzoic acid
- 4-methylphenol
- 2-methylphenol
- 2,4,5-trichlorophenol
- aniline
- benzyl alcohol
- 4-chloroaniline
- dibenzofuran
- 2-nitroaniline
- 3-nitroaniline
- 4-nitroaniline
- acetone
- 2-butanone
- carbon disulfide
- 2-hexanone
- 4-methyl 1-2-pentanone
- 2-methylnpahthalene
- styrene
- vinyl acetate
- alpha-xylene
- total xylenes

Base/Neutrals (sediment)
- acenaphthene
- benzidine
- 1,2,4-trichlorobenzene
- hexachlorobenzene
- fluoranthene
- isophorone
- naphthalene
- 2-chloronaphthalene
- bis(2-ethylhexyl) phthalate
- butylbenzyl phthalate
- di-n-octyl phthalate
- benzo(a)anthracene
- benzo(a)pyrene
- benzo(k)fluoranthene
- chrysene
- acenaphthylene
- phenanthrene
- hexachloroethane
- bis(2-chloroethyl) ether
- 1,2-dichlorobenzene
- 1,3-dichlorobenzene
- 1,4-dichlorobenzene
- 3,3'-dichlorobenzidine
- 2,4-dinitrotoluene
- 2,6-dinitrotoluene
- 1,2-diphenylhydrazine (as azobenzene)
- pyrene
- 3,4-benzofluoranthene
- anthracene
- benzo(ghi)perylene
- fluorene
- 4-chlorophenyl phenyl ether
- 4-bromophenyl phenyl ether
- phenol
- bis(2-chloroisopropyl) ether
- bis(2-chloroethyxy) methane
- hexachlorobutadiene
- hexachlorocyclopentadiene
- nitrobenzene
- N-nitrosodiphenylamine
- N-nitrosodi-n-propylamine
- di-n-butyl phthalate
- dimethyl phthalate
- dibenzo(a,h)anthracene
- ideno(1,2,3-cd)pyrene

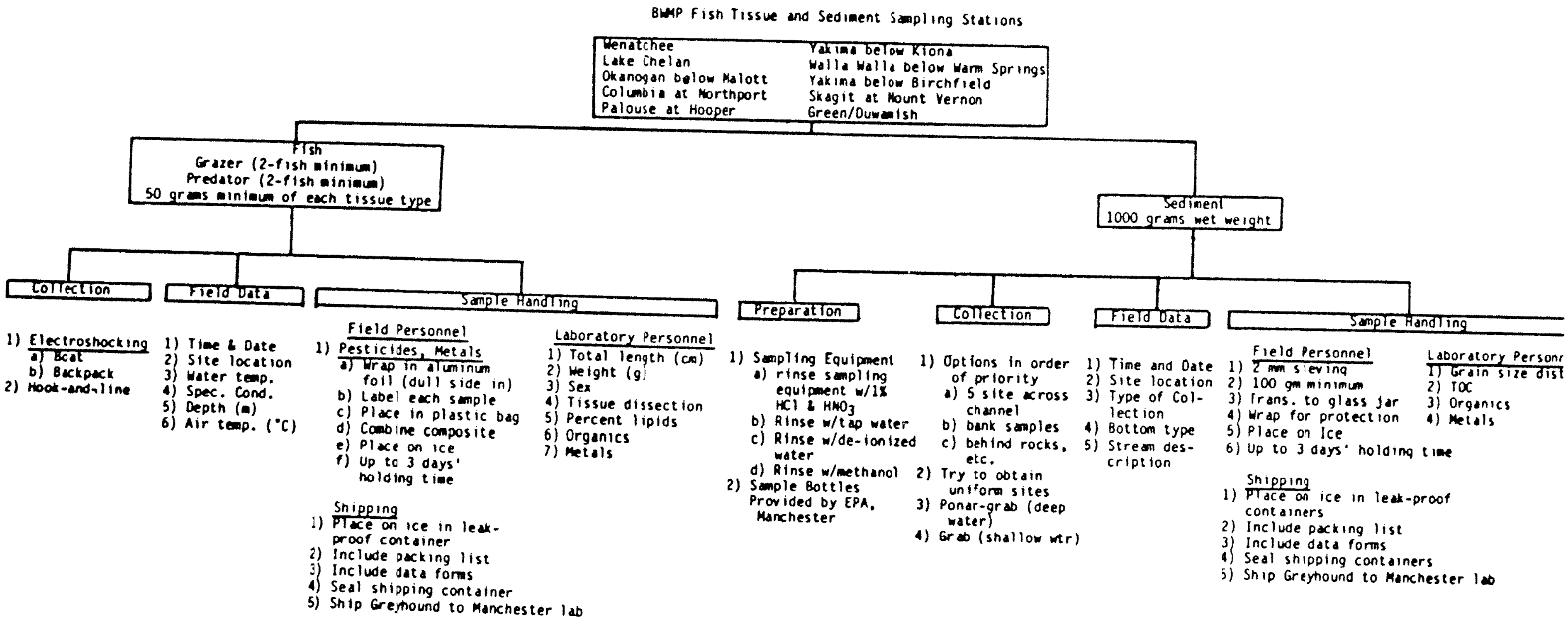

Figure 2. Organizational chart for the 1984 BWMP sampling program in Washington State.

If electroshocking did not result in successful capture of a target group (primarily predators), the hook-and-line method was used. A variety of both natural baits and artificial lures provided minimal success. Samples collected using this method were handled the same as if electroshocked.

Sediment samples were collected with a six-inch ponar grab, prepared as outlined in Figure 2 under "sediment preparation." The samples were collected downstream from the fish tissue collection site, whenever possible, and before electrofishing commenced.

Sample Handling

Field Personnel

Upon completion of sample collection, the fish were immobilized with a blow from a blunt object. The specimens were then composited by species, wrapped in aluminum foil (dull side in), and placed in a plastic bag. All packaged samples were tagged and placed on ice. The samples were then shipped to the laboratory for further preparation and analyses.

Upon collection with the ponar, the sediment samples were run through a 2 mm stainless steel seive into a stainless steel beaker to remove gravel and larger sized particles, both items previously washed following the same method used on the ponar grab. The sample was allowed to settle before most of the supernatant was poured off. The remaining supernatant and sediment was poured into glass containers suitable for organic analysis. The containers were labeled, packaged, and placed on ice. The containers were combined with the fish tissue samples and shipped to the Manchester laboratory.

Laboratory Personnel

Upon arrival, the biological information on total length (cm), weight (g), and sex was recorded for each fish. The fish were then dissected into composites of liver, gill, and fillet tissues. Utensils used for dissecting were first washed with phosphate-free detergent (Liqui-Nox), and double-rinsed with both tap water and de-ionized water. They were then acid-rinsed with a 10 percent HCl solution and again with de-ionized water. This procedure was followed by double-rinsing with acetone and methylene chloride. The utensils were then dried in a 105°C oven for 10 minutes before use.

All samples were handled with solvent-cleaned Viton gloves and dissected on solvent-cleaned aluminum foil. Upon completion of dissection, the tissue composites were placed in commercially prepared, organic-free glass jars and frozen pending analysis. Prior to analysis, each composite tissue sample was thawed and ground using either a Waring blender or a Hobart commercial meat grinder, depending on the size of the sample. The grinding equipment was solvent-cleaned before use and between samples.

Upon arrival at the laboratory, sediments samples were stored at 4°C and protected from light until extraction could be performed.

Laboratory Procedures

Fish Tissue

The method used for the quantification of polychlorinated biphenyls (PCBs), chlorinated pesticides, and pentachlorophenol (PCP) in biological tissues involved liquid extraction, Florisil column chromatography, and gas chromatographic electron capture (GC/EC) analysis.

PCBs, Chlorinated Pesticides, PCP

For liquid extraction, a 20 gm sub-sample of tissue homogenate was added (with the appropriate surrogate internal standard compounds when required) to a 200 mL centrifuge tube containing 80 mL of acetone. The tissue was ground with a Brinkmann Polytron tissue homogenator for three minutes or until the acetone fully saturated the tissue. The homogenate was centrifuged for two minutes at 1500 rev/min to allow the finely divided tissue to separate from the acetone supernatant. The supernatant was then decanted through a Whatman #1 filter paper into a 500 mL flask. The filtration/extraction process was repeated twice and the resulting extracts combined. The acetone tissue extract was then concentrated in a steam bath until a visible water-acetone phase separation occurred (usually 5 to 15 mL residual volume). Next, the extracted solvent was exchanged to petroleum ether (30 to 60 ppb range) and dried with anhydrous sodium sulfate (heated overnight at 450°C). The dried extract was transferred to a 500 mL Kudera-Danish (K-D) concentrator flask, and the volume was reduced to approximately 10 mL.

For the chromatography procedures, the extract was applied to the bed of a 10.2 cm x 2.0 cm Florisil (EPA Research Triangle Park) column, capped at either end with 1.5 cm of anhydrous sodium sulfate. Next, the compounds of interest were eluted with a combined solvent of 50 percent petroleum ether/50 percent diethyl ether. The flask was then fitted with a three-ball cylinder condensing column, and the extracted volume was reduced to approximately 10 mL in a steam bath. The petroleum ether extract was exchanged to iso-octane and adjusted to a final volume of 10 mL for subsequent gas chromatographic analysis.

PCBs (only)

To remove DDT analog interferences for the quantification of PCBs, a portion of the extract was subjected to dehydrochlorination. The dehydrochlorination forms the olefins of bis(phenyl)chloroethane pesticides; e.g., converts p,p'-DDT, o,p'-DDT, p,p'-DDD to p,p'-DDE, allowing a "window" in the gas chromatogram for PCB confirmation and quantitation. The procedure which is outlined in Manual of Analytical Methods for the Analysis of Pesticides in Humans and Environmental Samples (EPA, 1980b) involves alkali treatment with 2 percent KOH on a steam bath for approximately 30 minutes. Subsequent extraction with 1:1 ethanol-water + iso-octane yields the converted olefin products for GC/EC analysis. PCB components ranging from 21 to 60 percent chlorine were found to be stable to the dehydrochlorination procedure.

PCP (only)

A portion of the organic extract after initial extraction was retained for PCP analysis. The extract was then exchanged to diethyl-ether (ethanol-free). Methyl esterification of the PCP was accomplished using EPA method 615.(10.2.2) (EPA, 1980b). The extract was exchanged to iso-octane and column chromatographed with 5 mL of iso-octane on a 5.0 x 0.5 cm Florisil micro column. The iso-octane elutent was then concentrated to 1.0 mL and analyzed by GC/EC.

Metals

For the metals arsenic, cadmium, chromium, copper, lead, and zinc, approximately 3 gm of sample were placed in a 150 mL beaker. After the addition of 5 mL concentrated HNO_3, the sample was covered with a watch glass and heated on a hotplate until the tissue liquified. Three mL 30 percent H_2O_2 were added and the sample refluxed until orange fumes were no longer produced. In cases where quantities of fats remained in the digested sample, a few drops of H_2SO_4 were added and the sample was further refluxed until orange fumes were no longer produced. After digestion was complete, 2 mL each concentrated HNO_3 and 30 percent H_2O_2 were added, and the volume was brought to 100 mL with deionized water.

Analysis was accomplished using a computer-assisted Perkin Elmer 5000 Atomic Absorption Spectrophotometer, analyzing copper, zinc, and chromium using the flame; and arsenic, cadmium, and lead using the graphite-furnace mode.

The procedure for mercury was different from the other metals. Approximately 5 gm of sample were weighed into a clean BOD bottle. Five mL each of concentrated HNO_3 and H_2SO_4 were added, and the samples were placed in a 90°C water bath for a few minutes until the tissue liquified. After cooling, 0.1 gm each of $KMnO_4$ and $K_2S_2O_8$ were added, and the samples stoppered and heated in a 90°C water bath for 30 minutes. Additional $KMnO_4$ and $K_2S_2O_8$ were added and the sample reheated if the $KMnO_4$ color cleared during the initial digestion process. After cooling, the samples were brought to an approximate volume of 120 mL with de-ionized water. Samples were analyzed on a Perkin Elmer 403 Atomic Absorption Spectrophotometer using the cold vapor method. For analysis, 5 mL of NaCL hydroxalamine hydrochloride were added and swirled until the purple color disappeared. Five mL stannous sulfate were added, and nitrogen gas was bubbled through the sample. Peaks proportional to the mercury content in the vapor were recorded using a chart recorder, and mercury concentration calculated using a standard curve (EPA, 1982).

Sediments

Grain-size analysis was performed to estimate percent fractions of gravel (>2 mm), sand (<2 mm to 62 um), silt (62 to 4 um), and clay (<4 um). An approximate 50 gm wet-weight sample was wet-seived through 2 mm and 62 micron screens. Material retained on the screens was dried (80°C for 24 hours) and weighed to give total sample contributions for gravel and sand, respectively. Material washed into the pan was transferred to a one-liter graduated cylinder, and distilled water was added to bring the total volume to one liter. The graduated cylinder was stoppered and mixed by inverting it for one minute and then allowing it to stand for 20 seconds. A 25 mL sample was pipetted from 20 cm depth for silt plus clay, and after two hours, three minutes, at the 10 cm depth for clay. Contents of the pipettes were dried (80°C for 24 hours) and the residue was weighed. Weight of residue times 50 was used to calculate total weight of silt and clay in sample. Percent contribution of each fraction was based on the aggregate weight of all fractions.

The total organic carbon (TOC) procedure involved drying approximately 10 gms of the sediment at 70°C. The dry sample was then screened through a 10-mesh sieve and ground to 100-mesh. An 0.5 gm sub-sample of this dried, ground sediment was weighed in a TOC boat. The boat was placed in a desiccator containing concentrated HCl for 48 hours. The sediment was then placed in a 70°C oven for at least one hour prior to ignition. After drying, the boat containing the treated sediment was inserted into the combustion zone of a Lindberg Tube furnace. The furnace was held at 900 to 1000°C. Oxygen was used as the sweep gas, and a trap containing ascarite and silica gel was at the end of the train. The sample was allowed to burn for at least two minutes, and the gases were collected. The trap was weighed before and after ignition of the sediment. The weight gain is CO_2. This CO_2 measurement was used to calculate the percent TOC in the sediment.

Pesticides, PCBs, base/neutrals, and acid extractable compounds were measured using EPA methods 608 (Pesticides and PCBs) and 625 (Base/Neutrals and Acids) (Federal Register, 1984a).

For the metals analysis (arsenic, cadmium, chromium, copper, lead, and zinc), approximately 25 gm of sample were dried in a 205°C oven for 24 hours. The sample was then seived and 1 gm was weighed out for digestion. The digestion and other analytical procedures were the same as for the fish tissue. The overall procedure for mercury was the same as described for fish tissue.

Quality Assurance

Quality assurance included replicate samples collected in the field; and replicate sub-samples, surrogate pesticide addition, duplicates and sample spikes in the laboratory. The results for surrogate, spikes, and duplicate recoveries can be found in Appendix II.

RESULTS AND DISCUSSION

Within the guidelines set down in the BWMP program, the data collected are intended to provide an overview of environmental quality in river systems throughout the State of Washington. It is not the goal of this program to identify specific sources of pollution, but to point out possible problem areas that should be investigated more intensively. The historical BWMP data are attached to this report (Appendix I), but are not compared with the 1984 findings because different sampling, handling, and detection limits were used from year to year. This historic data in itself should not be used for individual site comparisons, but could have limited use as a verifying tool for the current effort.

The results for chlorinated pesticides, PCB mixture (quantified as 1260), and metals analysis of the fish tissue and sediment can be found in Tables 2 and 3, respectively. Substances analyzed for but not detected at the given detection limits can be found on Table 4. Lipid-weight normalized data for t-DDT (DDE + DDD + DDT) and PCB mixture in the fish tissue can be found on Table 5. It is thought that lipid-normalized values provide a more accurate picture of the actual availability of liphophilic substance than do wet-weight values. Lipid-normalizing standardizes the amount of a liphophilic compound (ug/kg wet weight) per unit of lipid. Therefore, the lipid-normalized values should be considered when comparison among stations is attempted. The results for t-DDT, PCBs, and hexachlorocyclohexane are also presented in graphic form in Figures 3 through 8.

Table 5. Lipid-weight based results for t-DDT and PCB mixture on fish tissue sample collected as part of the 1984 BWMP sampling program in Washington State (ug/Kg lipid).

Location	Organism	Tissue Type	t-DDT Forms	PCB Mixture	Percent Lipids
Wenatchee	Bridgelip sucker	Edible	150,000	20,500	0.2
	Mountain whitefish	Edible	18,900	600	7.4
Chelan	Bridgelip sucker	Edible	400,000	19,700	0.3
	Squawfish	Edible	100,000	3,700	1.1
Okanogan	Bridgelip sucker	Edible	118,500	--	2.7
	Bridgelip sucker	Liver	64,900	900	23.1
	Largemouth bass	Edible	42,800	500	4.2
Columbia River	Bridgelip sucker	Edible	2,500	3,700	2.6
	Replicate	Edible	7,300	3,500	2.6
Palouse River	Longnose sucker	Edible	5,200	--	2.5
	Northern squawfish	Edible	12,700	--	1.1
Walla Walla	Mountain sucker	Edible	40,000	--	0.7
Yakima River below Kiona	Bridgelip sucker	Edible	76,900	4,600	2.6
	Bridgelip sucker	Liver	63,300	3,800	23.7
	Northern squawfish	Edible	91,700	5,000	2.4
Yakima River at Birchfield Drain	Bridgelip sucker	Edible	43,800	7,400	1.3
	Replicate	Edible	25,000	2,000	2.6
	Northern squawfish	Edible	128,600	5,700	2.1
	Mountain whitefish	Edible	70,000	4,800	2.0
	Mountain whitefish	Liver	21,700	1,600	8.3
Skagit	Bridgelip sucker	Edible	26,700	6,000	0.6
	Mountain whitefish	Edible	2,800	1,100	2.6
Green	Bridgelip sucker	Edible	62,500	17,500	2.4
	Northern squawfish	Edible	35,700	21,100	2.8
	Northern squawfish	Liver	14,000	7,100	10.7

-- = Wet weight results given as "less than" values.

Table 2. Results of fish tissue analysis as part of the 1984 BWMP sampling program in Washington State (ug/Kg wet weight).

Location	Collection Date	Organism	Tissue	Sample Weight	Percent Lipids	Percent Solids	DDT o,p'	DDT p,p'	DDD o,p'	DDD p,p'	DDE o,p'	DDE p,p'	Total DDT Forms	Alpha-BHC	Aroclor 1260	PCP	Metals: Arsenic	Cadmium	Chromium	Copper	Mercury	Lead	Zinc
Wenatchee River at Wenatchee 45A070	9/03/84	Bridgelip sucker	Edible	22.67	0.2	22.1	11	23	[3]	62	10	190	300	2	41	1u	70	100	[<30**]	1500	21	330	[36,900]
			Liver	5.45	--	21.0	45	130	1u**	210	49	740	1200	11	85	1u	[1170]	1730	700	9700	--	<100	41,700
			Gills			23.7											<30	100	<30	1600	10	70	26,400
		Mountain whitefish	Edible	23.60	7.4	30.3	97	250	[4]	120	1u	910	1400	23	46	6	<30	10	[<30**]	1800	17	<30	[70,700]
			Liver	6.23	--	42.8	53	160	1u**	61	47	610	920	12	45	28	[60]	<30	100	1000	--	100	[40,600]
			Gills			35.7											130	40	<30	1500	14	<30	25,000
Lake Chelan near Lake Outlet Dam 47A070	9/04/84	Bridgelip sucker	Edible	26.65	0.3	23.1	1u	44	1u	110	26	990	1200	1	59	5m	[270]	<30	<30	1700	5	<30	21,900
			Liver	11.79	--	19.4	1u	95	61	310	10	1500	2100	10	190	4	--	--	--	--	--	--	--
			Gills			--											<30	100	<30	1900	5	170	21,700
		Northern squawfish	Edible	24.41	1.1	22.9	32	75	1u	31	1u	1000	1100	3	41	1	30	30	<30	2200	35	<30	18,100
			Liver	3.85	--	24.3	1u	39	1u	193	1u	6100	6400	7	110	1u	--	--	--	--	--	--	--
			Gills			--											<30	30	<30	1200	39	<30	20,900
Okanogan River below Malott 49A070	9/13/84	Bridgelip sucker	Edible	23.77	2.7	23.0	11	64	1u	[780]	6	[2400]	[3200]	3	10u	1u	30	20	<30	1400	45	<30	16,900
			Liver	8.98	23.1	36.6	1u	200	[500]	[3500]	630	[10,600]	[15,000**]	49	210	8	<30	<30	<100	6700	--	100	19,900
			Gills			24.1											100	20	<30	2000	9	<30	16,400
		Largemouth bass	Edible	20.92	4.2	25.8	15	62	1u	[270]	38	1400	1800	3	22	6	[270]	<10	<30	1500	49	<30	13,200
			Liver	3.93	--	56.9	1u	200	89	540	130	2100	3100	12	10u	6	--	--	--	--	--	--	--
			Gills			33.4											<30	20	<30	2100	20	<30	25,200
Columbia River at Northport 61A070	9/05/84	Bridgelip sucker	Edible	21.50	2.6	21.6	19	17	1u	15	1u	15	66	4	97	2	<30	100	<30	2100	73	4300	29,000
			Liver	10.81	--	25.2	5	37	1u	32	1u	31	110	11	140	7	600	2060	[500]	[24,300]	--	[4400]	[77,300]
			Gills			24.6											<30	140	<30	2800	29	6700	31,100
		Replicate	Edible	28.57	2.6	23.9	23	68	1u	58	18	23	190	13	90	2	<30	[210]	<30	1800	51	[8100]	30,500
			Liver	9.21	--	27.8	1u	63	1u	110	1u	97	270	21	300	3	<30	[5930]	100	15,100	--	1400	48,000
			Gills			20.6											170	150	<30	1500	24	18,000	58,400
Palouse River at Hooper 34A070	9/11/84	Longnose sucker	Edible	21.09	2.5	22.8	1u	23	1u	10	1u	92	130	37	10u	1u	70	10	<30	1800	34	<30	19,800
			Liver	3.76	--	32.3	28	95	1u	79	55	410	670	220	10u	80	--	--	--	--	--	--	--
			Gills			26.6											<30	20	<30	1900	6	70	20,800
		Northern squawfish	Edible	18.95	1.1	20.4	1u	2	1u	5	1u	130	140	16	10u	1u	<30	[50]	<30	2300	85	<30	16,800
			Liver	1.70	--	43.7	1u	1u	1u	24	1u	480	510	46	10u	1u	--	--	--	--	--	--	--
			Gills			--											<30	30	<30	1700	31	<30	34,800
Walla Walla River blw Warm Springs 32A070	9/12/84	Mountain sucker	Edible	24.01	0.7	21.2	33	64	1u	40	49	92	280	10	10u	5u	100	<10	<30	1300	23	<30	13,200
			Liver	6.59	--	18.8	1u	1u	1u	23	1u	200	220	11	10u	14	--	--	--	--	--	--	--
			Gills			21.7											<30	10	<30	2100	5	<30	15,300
Yakima River below Kiona 37A090	9/12/84	Bridgelip sucker	Edible	21.46	2.6	26.2	98	330	1u	150	[47]	1300	2000	6	120	1m	30	20	<30	[7300]	100	2000	23,200
			Liver	19.81	23.7	32.3	[590]	[1000]	1u	1200	[970]	[11,000]	[15,000**]	47	[910]	32	330	<30	200	3500	--	<100	18,600
			Gills			26.9											230	10	<30	3700	24	370	17,700
		Northern squawfish	Edible	20.90	2.4	24.1	130	140	1u	90	[99]	1700	2200	6	120	1m	30	10	<30	2300	120	<30	16,300
			Liver	6.07	--	39.6	1u	640	1u	460	690	12,000	13,000	1u	[2000]	18	<30	<30	100	7400	--	<100	16,500
			Gills			27.3											<30	70	<30	2600	24	200	29,300
Yakima River at Birchfield Drain 37A195	9/14/84	Bridgelip sucker	Edible	20.42	1.3	22.8	37	140	1u	14	23	360	570	2	96	1m	<30	30	<30	1500	[250]	<30	26,800
			Liver	4.68	--	21.6	200	360	1u	140	66	1200	1900	21	310	6	100	100	100	7400	--	<100	30,700
			Gills			17.3											<30	20	800	1700	33	170	35,500
		Replicate	Edible	22.76	2.6	21.7	38	163	1u	48	39	370	650	6	53	2	<30	10	<10	2100	140	<30	18,500
			Liver	4.09	--	36.7	190	663	1u	320	1u	1400	2600	23	220	12	140	<30	100	6300	--	300	30,300
			Gills			18.6											<30	<10	<30	1800	27	<30	16,000
		Northern squawfish	Edible	21.19	2.1	24.0	41	41	1u	250	63	[7300]	[2700]	3	120	1m	<100	10	<30	[2700]	[780]	[170]	12,600
			Liver	2.62	--	--	[1200]	[1130]	[560]	[2400]	[1400]	[21,000]	[26,000]	42	880	16	--	--	--	--	--	--	--
			Gills			--											<30	10	<30	2200	300	<30	27,000
		Mountain whitefish	Edible	20.97	2.0	21.0	52	57	22	48	71	1100	1400	7	97	1m	200	10	<30	1700	640	<30	14,700
			Liver	8.62	8.3	31.5	31	130	1u	93	1u	1500	1800	9	130	3	<30	<30	[200*]	5800	--	[600]	20,800
			Gills			21.9											<30	20	<30	2100	140	<30	24,600
Skagit River below Mount Vernon 03A060	9/18/84	Bridgelip sucker	Edible	23.55	0.6	21.0	20	47	1u	31	25	33	160	4	36	[40]	<30	10	<30	1500	110	<30	18,600
			Liver	7.70	--	22.8	24	100	1u	70	55	120	380	1	150	[340]	370	170	100	5800	--	<100	21,600
			Gills			18.7											30	10	<30	1530	33	30	15,200
		Mountain whitefish	Edible	22.59	2.6	21.5	11	19	1u	5	11	28	74	4	28	2	<30	10	<30	2230	30	70	15,000
			Liver	1.50	--	25.0	1u	1u	1u	1u	1u	18	18	3	10u	4	--	--	--	--	--	--	--
			Gills			--											70	20	<30	1300	36	<30	18,800
Green/Duwamish above Allentown 09A060	9/19/84	Bridgelip sucker	Edible	22.42	2.4	21.4	[220]	[340]	1u	320	1u	630	1500	[17]	[420]	10	<30	<10	<30	2200	130	100	15,100
			Liver	6.12	--	36.7	73	970	1u	240	250	430	2000	[460]	600	170	<30	300	100	7100	--	<100	23,900
			Gills			--											30	20	<30	1500	40	<30	11,400
		Northern squawfish	Edible	22.64	2.8	25.5	[140]	[470]	1u	160	120	160	1000	[59]	[590]	[55]	<30	10	<30	1000	530	<30	16,500
			Liver	4.95	10.7	29.8	330	300	1u	340	1u	490	1500	[220]	760	[101]	<30	[430]	[200*]	[24,600]	--	<100	27,300
			Gills			21.2											<30	90	<30	1600	150	<30	25,000

-- = Insufficient sample available for determination.
m = Indicates an estimated concentration.
u = Analyzed for but not detected at detection limit shown.
[ ] = Highest observed value for trophic level and tissue.
* = Tie
** = Uniform low

Table 3. Pesticide, PCB (ug/Kg dry weight), and metals results (mg/Kg dry weight) on sediment collected as part o the 1984 BWMP sampling program in Washington State.

Location	p,p' DDT	p,p' DDE	p,p' DDD	BHC Alpha	PCB 1260	As	Cd	Cu	Cr	Hg	Pb	Zn
Wenatchee River at Wenatchee	1u	7	1u	1u	10u	0.8	0.4	19.7	20.5	<0.008	<0.1	42.
Lake Chelan near Lake Outlet Dam	10	32	53	13	10u	1.7	1.6	19.3	6.6	0.02	13.3	124
Walla Walla River below Warm Springs	1u	1u	1u	1u	10u	1.7	0.7	11.7	<0.1	<0.007	<0.1	60.
Okanogan River below Malott	17	18	21	2	10u	15.5	2.0	60.7	<0.1	0.024	0.8	68.
Yakima River below Kiona	35	51	23	1u	10u	2.8	1.4	35.8	<0.1	0.038	4.2	82.
Yakima River at Birchfield Drain	1u	5	1u	1u	10u	1.0	0.6	16.7	0.6	0.018	0.7	54.
Skagit River below Mount Vernon	1u	2	1u	1u	10u	4.4	0.5	16.1	15.8	<0.006	<0.1	37.
Green/Duwamish above Allentown	1u	3	1u	1u	10u	3.3	1.1	19.1	15.7	0.02	<0.1	63.
Columbia River at Northport	1u	1u	1u	2	10u	18.8	13.4	171.3	5.4	0.196	189.0	158
Palouse River at Hooper	3	3	2	5	10u	1.2	0.6	14.7	<0.1	<0.007	<0.1	47.

u = analyzed for but not detected at detection limit shown.
< = less than

Table 4. Compounds analyzed for but not detected in sediment and fish tissue samples collected during the 1984 BWMP sampling program in Washington State.

Parameter	Detection Limit Wet-Weight Basis (ug/Kg)
Pesticides (sed. and fish tissue)	
aldrin	1.0
dieldrin	1.0
chlordane	1.0
methoxychlor	1.0
Acid Compounds (sediment)	
2,4,6-trichlorophenol	10
p-chloro-m-cresol	10
2-chlorophenol	10
2,4-dichlorophenol	10
2,4-dimethylphenol	10
2-nitrophenol	10
4-nitrophenol	20
2,4-dinitrophenol	25
4,6-dinitro-o-cresol	25
pentachlorophenol	20
Non-Priority Pollutants (sediment)	
benzoic acid	10
4-methylphenol	10
2,4,5-trichlorophenol	10
aniline	10
benzyl alcohol	10
4-chloroaniline	20
dibenzofuran	25
2-nitroaniline	10
3-nitroaniline	10
4-nitroaniline	10
acetone	variable
2-butanone	variable
carbon disulfide	variable
2-hexanone	variable
4-methyl 1-2-pentanone	variable
styrene	variable
vinyl acetate	variable
alpha-xylene	variable
total xylenes	variable

Parameter	Detection Limit Wet-Weight Basis (ug/Kg)
Base/Neutrals (sediment)	
acenaphthene	5
benzidine	50
1,2,4-trichlorobenzene	10
hexachlorobenzene	10
hexachloroethane	10
bis(2-chloroethyl) ether	10
1,2-dichlorobenzene	10
1,3-dichlorobenzene	10
1,4-dichlorobenzene	10
3,3'-dichlorobenzidine	20
2,4-dinitrotoluene	10
2,6-dinitrotoluene	10
1,2-diphenylhydrazine (as azobenzene)	10
3,4-benzofluoranthene	50
anthracene	5
benzo(ghi)perylene	10
fluorene	10
4-chlorophenyl phenyl ether	10
4-bromophenyl phenyl ether	10
bis(2-chloroisopropyl) ether	10
bis(2-chloroethyxy) methane	10
hexachlorobutadiene	10
hexachlorocyclopentadiene	10
nitrobenzene	10
N-nitrosodiphenylamine	20
N-nitrosodi-n-propylamine	20
di-n-butyl phthalate	5
dimethyl phthalate	10
dibenzo(a,h)anthracene	10
ideno(1,2,3-cd)pyrene	10
2-chloronaphthalene	10

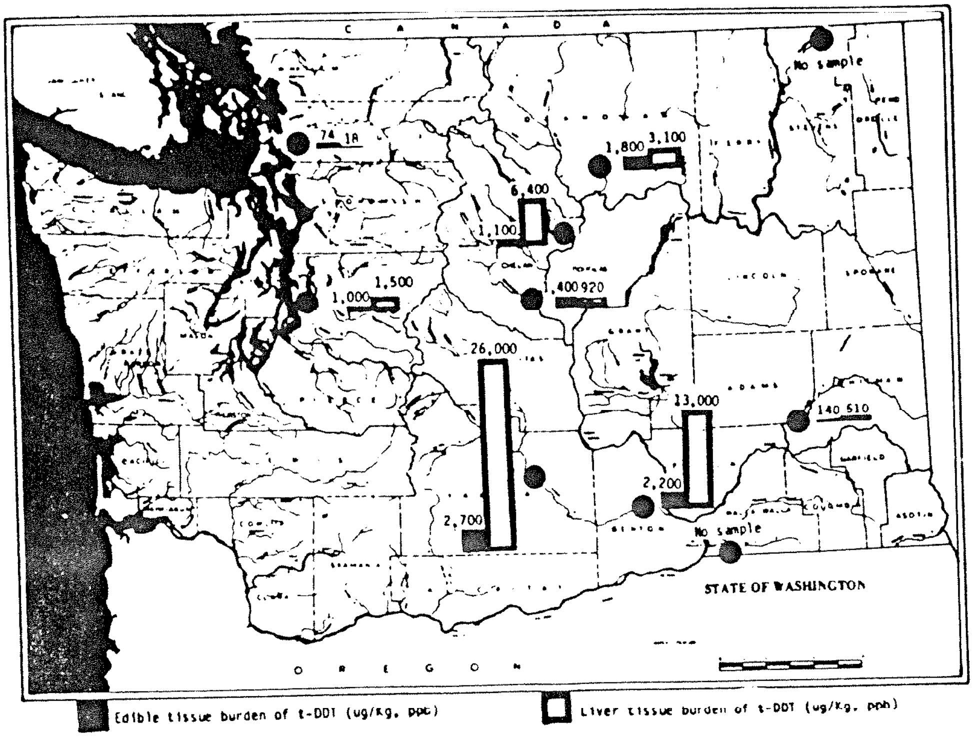

Figure 3. Total DDT (t-DDT = DDT + DDD + DDE) levels in predator species as part of the 1984 BWMP sampling program in Washington State (wet weight).

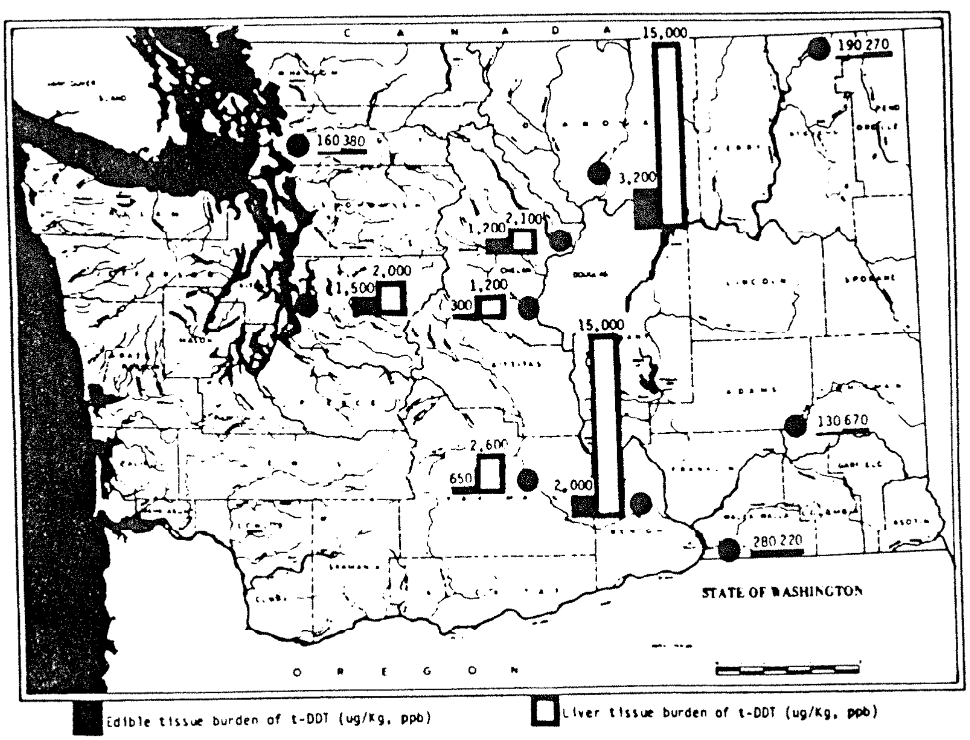

Figure 4. Total DDT (t-DDT = DDT + DDD + DDE) levels in grazer species as part of the 1984 BWMP sampling program in Washington State (wet weight).

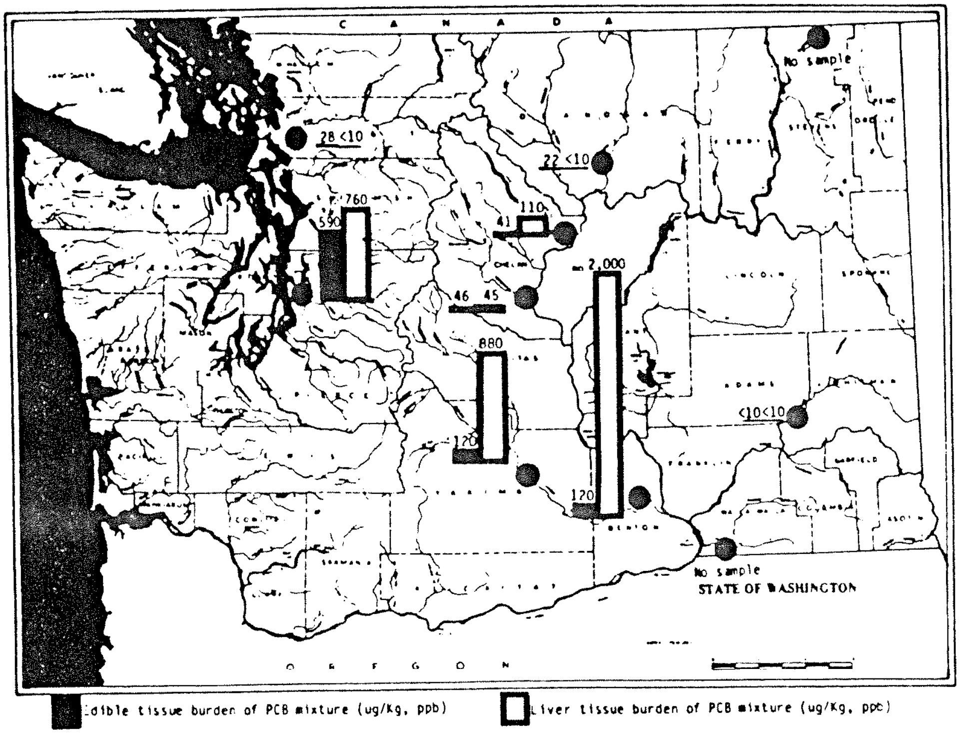

Figure 5. Polychlorinated biphenyl (PCB) mixture quantified as Aroclor 1260 in predator species as part of the 1984 BWMP sampling program in Washington State (wet weight).

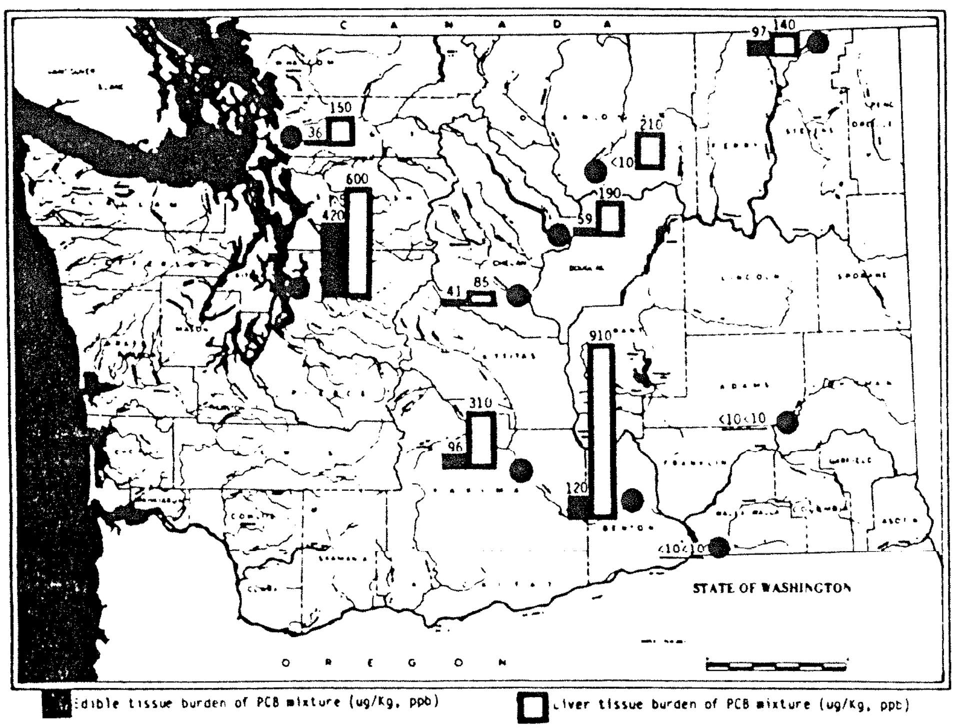

Figure 6. Polychlorinated biphenyl (PCB) mixture quantified as Aroclor 1260 in grazer species as part of the 1984 BWMP sampling program in Washington State (wet weight).

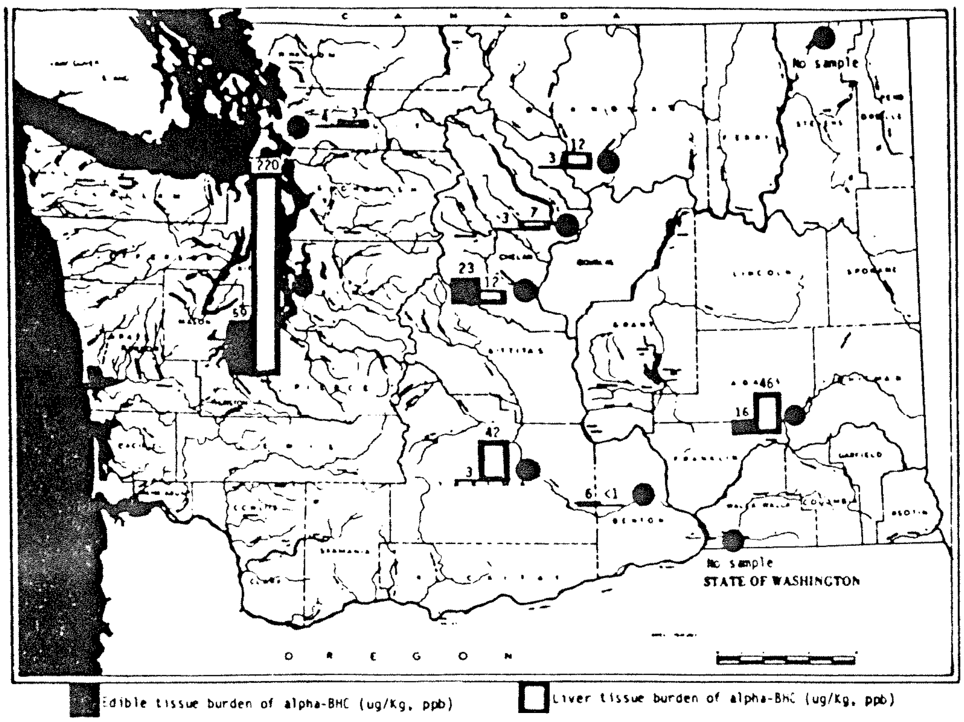

Figure 7. Hexachlorocyclohexane (alpha-BHC) levels in predator species as part of the 1984 BWMP sampling program in Washington State (wet weight).

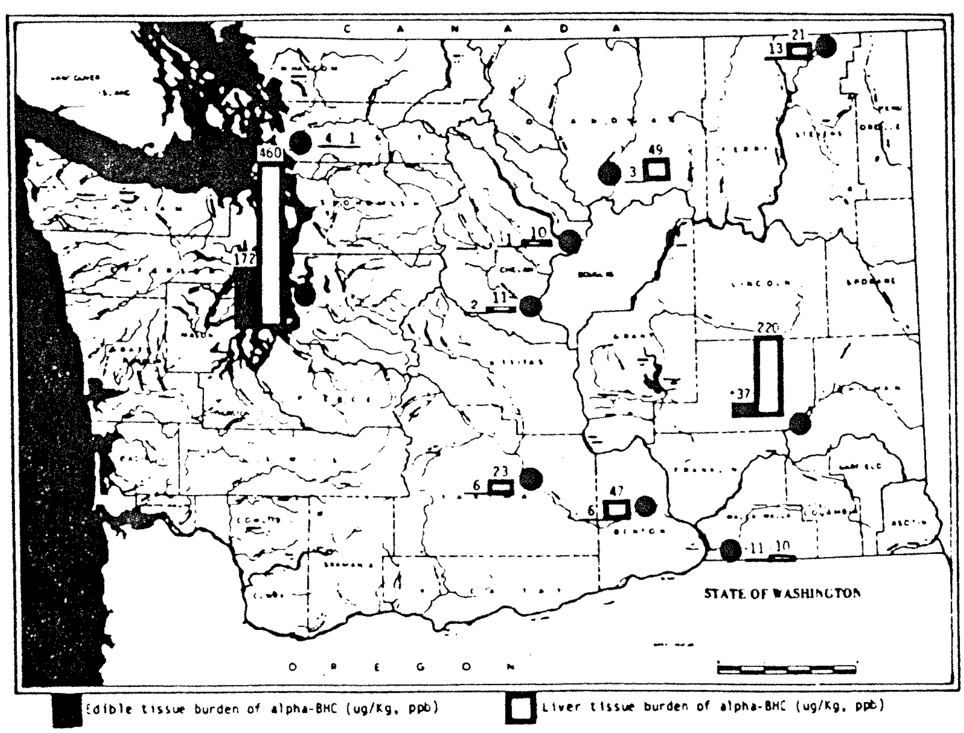

Figure 8. Hexachlorocyclohexane (alpha-BHC) levels in grazer species as part of the 1984 BWMP sampling program in Washington State (wet weight).

TOC and particle size analysis results used in sediment normalization are presented in Table 6.

Table 6. Total organic carbon and particle size analysis on sediment collected as part of the 1984 BWMP sampling program in Washington State.

Location	Percent TOC	Percent Particle Size			
		Gravel ≥2 mm	Sand 2mm - ≤62um	Silt 62um - ≥4um	Clay <4um
Wenatchee River at Wenatchee	0.5	0.02	97.21	0.92	1.84
Lake Chelan near Lake Outlet Dam	0.8	0.01	96.72	0	3.29
Okanogan River below Malott	0.9	0	37.81	55.80	6.38
Columbia River at Northport	0.1	0	96.28	3.72	0
Palouse River at Hooper	1.1	0	82.21	14.24	3.56
Walla Walla River below Warm Springs	0.4	0.05	93.01	5.95	0.99
Yakima River below Kiona	1.7	0	43.12	37.91	18.96
Yakima River at Birchfield Drain	1.2	0	95.38	2.77	1.85
Skagit River below Mount Vernon	1.0	1.03	98.08	0	0.88
Green/Duwamish above Allentown	0.3	0.03	98.90	0	1.10

EVALUATION BY CLASS OF COMPOUNDS

Dichlorodiphenyl trichloroethane (DDT)

The top five t-DDT concentrations found in edible fish tissue in the 1984 BWMP samples are presented in Table 7 as wet-weight values and on a lipid-normalized basis.

Table 7. Top five t-DDT concentrations found in edible fish tissue as part of the 1984 BWMP sampling program in Washington State.

Sample Site	Species	Wet-Weight Value (ug/Kg)	Sample Site	Species	Lipid-Normalized Value (ug/Kg lipid)
1. Okanogan	Bridgelip sucker	3,200	Chelan	Bridgelip sucker	400,000
2. Yakima B	Northern squawfish	2,700	Wenatchee	Bridgelip sucker	150,000
3. Yakima K	Northern squawfish	2,200	Yakima B	Northern squawfish	128,600
4. Yakima K	Bridgelip sucker	2,000	Okanogan	Bridgelip sucker	118,500
5. Okanogan	Largemouth bass	1,800	Chelan	Northern squawfish	100,000

Of the top five wet-weight values, both the Okanogan River and Yakima River at Birchfield samples (3,200 ug/Kg and 2,700 ug/Kg, respectively) approach the FDA limit of 5,000 ug/Kg in tissue for human consumption. In this study, 11 of 19 edible tissue samples (58 percent) collected exceeded the National Academy of Science (NAS) limit of 1,000 ug/Kg. This percentage, however, is not strictly comparable because the NAS recommended level is based on whole-fish values and WDOE values reflect edible tissue only.

The top five sediment t-DDT values on a dry-weight basis and TOC-normalized values can be found in Table 8.

Table 8. Top five t-DDT concentrations found in sediment collected as part of the 1984 BWMP sampling program in Washington State.

Sample Site	Dry-Weight t-DDT (ug/Kg)	Sample Site	TOC-Normalized Value (ug/Kg TOC)
1. Yakima Kiona	109	1. Chelan	11,875
2. Lake Chelan	95	2. Yakima Kiona	6,412
3. Okanogan	56	3. Okanogan	6,222
4. Palouse	8	4. Wenatchee	1,400
5. Wenatchee	7	5. Green	1,000

As with the DDT levels in fish tissue, it is considered that a normalized value, in this case TOC corrected, allows a more accurate comparison to be made among sediment samples collected at different locations. The sediment sample collected at Lake Chelan (11,875 ug/Kg TOC) showed a TOC-normalized value almost double that of second-ranked Yakima River at Kiona (6,412 ug/Kg TOC).

Hexachlorocyclohexane (alpha-BHC)

The 1984 BWMP program's edible tissue concentrations for alpha-BHC were all generally low except for a sample collected on the Green/Duwamish River (172 ug/Kg) which exceeded the NAS recommended level of 100 ug/Kg. The sediment data showed low levels at all sample sites.

Polychlorinated biphenyl (quantified as Aroclor 1260)

PCBs like alpha-BHC concentrations in edible fish tissue were low except for the samples collected on the Green/Duwamish River which had a sample value over (590 ug/Kg) and one approaching (420 ug/Kg) the NAS recommended level of 500 ug/Kg. The sediment samples, however, showed no values above detection limits.

Pentachlorophenol (PCP)

PCP values were low, with some samples approaching the method detection limits.

Metals

Guidelines for metals concentrations in fish tissue generally are unestablished. The FDA, however, has established an action level for mercury in edible fish tissue (FDA, 1982) which is 1,000 ug/Kg wet weight. The FDA has also set unofficial guidelines in other food types for cadmium and lead, these being 500 and 7000 ug/Kg wet weight, respectively (Johnson, 1985). The EPA also has a mercury standard that the total body burden in any aquatic organism should not exceed 0.5 mg/Kg wet weight to protect fish and predatory aquatic organisms (EPA, 1973). Using these standards for comparison, three BWMP sample sites approach or exceed the lead and mercury standards. The mean value for lead found in edible fish tissue samples collected at Columbia River at Northport is 6,400 ug/Kg (average of replicates) or over 90 percent of the recommended concentration. The Yakima River at Birchfield drain and the Green/Duwamish above Allentown had mercury levels in edible tissue of 780 ug/Kg and 530 ug/Kg, respectively, which are more than one-half the FDA guideline values and exceed the EPA recommended value.

Metals concentrations found in freshwater sediment, like fish tissue, have no established criteria. This is probably due in part to the different geochemical makeup which tends to be regional- if not site-specific. In Washington, approximately 1,900 stream sediment samples derived from different rock strata have been analyzed for zinc, lead, and copper. The mean values are 82 mg/Kg for zinc, <25 for lead, and 37 for copper (Moen, 1969). Using these values as a rough baseline for comparison with the BWMP sediment samples, the Columbia River at Northport appears to have elevated levels. Zinc, lead, and copper concentrations were found to be 1580, 189, and 171.3 mg/Kg, respectively.

Other metals found in BWMP sediment samples that showed possible signs of slight-to-moderate enrichment were arsenic and mercury. Those stations involved were the Okanogan River below Malott and the Columbia River at Northport. The remaining sediment sample results seem to be typical of those found in granitic rocks.

Priority Pollutants (sediment)

The acid/base neutral results from sediment collected during the 1984 BWMP sampling program are presented in Table 9. Most of the levels were below or

Table 9. Acid/base-neutral results (ug/Kg dry weight) in sediment collected as part of the 1984 BWMP sampling program in Washington State.

	Wenatchee River at Wenatchee	Lake Chelan near Lake Outlet Dam	Okanogan River below Malott	Columbia River at Northport	Palouse River at Hooper	Walla Walla River below Warm Springs	Yakima River below Kiona	Yakima River at Birchfield Drain	Skagit River below Mount Vernon	Green/Duwamish above Allentown
fluoranthene	5u	5u	9	73	5u	5u	15	5m	5u	10
isophorone	10u	10u	10u	10u	10u	10u	15	10u	10u	10u
naphthalene	10u	16	10u	32	10u	10u	15	10u	10u	10m
bis(2-ethylhexyl)phthalate	5u	82	40	61	33	58	53	42	20	37
butylbenzyl phthalate	5u	5u	5u	38	5u	5u	5u	5u	5u	5u
di-n-octyl phthalate	5u	5u	5u	5u	5u	5u	5u	5u	7	5u
diethyl phthalate	10u	10u	10u	10u	10u	10u	10m	10u	10u	10u
benzo(a)-anthracene	5u	34	5u	30	5u	5u	5u	5u	5u	5u
benzo(a)pyrene	10u	10u	10u	24	10u	10u	10u	10u	10u	10u
benzo(k)fluoranthene	50u	50m	50u	50m	50u	50u	50u	50u	50u	50u
chrysene	5u	47	5.6	30	5u	5u	13	5u	5u	5u
acenaphthylene	10u	10u	10u	15	10u	10u	10u	10u	10u	10u
phenanthrene	5u	50	13	120	5u	5u	25	17	5u	5u
pyrene	5u	59	11	50	5u	5u	16	5u	5u	5m
phenol	10u	10u	10u	10u	10u	10u	100	10u	10u	10u
2-methylphenol	10u	10u	10u	10u	10u	10u	810	10u	10u	10u
2-methylnaphthalene	10u	10u	10u	15	10u	10u	10m	10u	10u	10u

u = Analyzed for but not detected at detection limit shown.
m = Estimated concentration.

near detection limits, the exception being levels detected on samples collected at the Yakima River at Kiona and the Columbia River at Northport. The Kiona sample showed elevated levels of phenol and 2-methyl phenol. The Northport sample stands out in the frequency in which acid/base neutral compounds were detected.

REVIEW OF PERTINENT ORGANIC COMPOUNDS

The following descriptions are provided to give the reader some basic background information on the use and regulations established for selected compounds.

Dichlorodiphenyl trichloroethane (DDT)

DDT is a lipophilic (lipid-soluble), persistent pesticide that in its pure state is virtually insoluble in water--0.00001% (White-Stevens, 1971). Like other organochlorine insecticides, DDT is classified as a neuropoison. DDT was once the most commonly used chlorinated hydrocarbon insecticide, with total world production being estimated in excess of 2 million tons (Edwards, 1973). Being first synthesized as early as 1874, it was not used as an insecticide until its patent in 1942. From the mid 1940s to the late 1960s, DDT was used in wide application to forests, agricultural lands, and aquatic environments. The once heavily applied insecticide, however, fell into disfavor when studies began to show possible evidence of biomagnification in natural food chains. This combined with its toxic effect on non-target organisms led to the EPA restriction of DDT use in the United States in 1972. This restriction limits DDT applications only to emergency situations.

In the aquatic environment, DDT tends to be associated with the clay size fraction in the sediment and the lipid fraction of the biota. Aquatic organisms contact DDT in their ambient environment and associated food. The amount of DDT that the organism assimilates into total body burden from these sources is dependent on many variables that include, but are not limited to total body lipid level, age, water quality, sex, and season of year. Once incorporated into the body, DDT quickly becomes associated with lipids. The lipids of the organism act as a pseudo-detoxicant system by removing the DDT or metabolites from circulation within the body. With continued exposure, the total body burden of DDT stored in these lipids may continue to increase. It is this possible continued increase that lends itself to the concept of biomagnification. However, in recent years the concept of biomagnification has fallen into disfavor due in part to recent studies that fail to confirm previous findings.

The NAS used research, that indicated increased body burden of DDT as one moves up the food chain, as a basis for its recommendation that residues of DDT and its metabolites should not exceed a concentration of 1,000 ug/Kg wet weight in whole fish to protect predatory fish and wildlife (EPA, 1973). The FDA has also set a concentration limit of 5,000 ug/Kg wet weight in fish tissue for human consumption (Johnson, 1985). DDT and its metabolites (DDE and DDD) are listed as EPA priority pollutants.

Hexachlorocyclohexane (alpha-BHC)

Hexachlorocyclohexane is an organochlorine insecticide that is synthesized by reacting chlorine with benzene in the presence of ultraviolet light. It was produced and marketed under trade names of BHC, benzene hexachloride, and 666. Technical-grade BHC consists of five isomers found in the following range: alpha-isomer - 50 to 70%; beta-isomer - 6 to 8%; gamma-isomer - 10 to 20% (Lindane); delta-isomer - 3 to 4%; epsilon-isomer - trace amounts (EPA, 1980a). Of these five, Lindane is the isomer that possesses insecticidal properties. As BHC use increased, it was determined that a concentrated form of Lindane was more effective as an insecticide than technical-grade BHC. This combined with the fact that the alpha-isomer is persistent in the environment and toxic to non-target organisms has led to the almost exclusive use of concentrated gamma-isomer.

The Food and Agriculture Organization/World Health Organization (FAO/WHO) allowable daily intake (ADI) for BHC is 1 ug/Kg/day for each kilogram of a person's total body weight. The NAS has established a level of 100 ug/Kg as their respective guideline (EPA 1973). EPA lists hexachlorocyclohexane as a priority pollutant.

Polychlorinated biphenyl (PCB)

Polychlorinated biphenyls (PCBs) are synthesized by complete or partial chlorination of the biphenyl molecule. The resulting molecule is reasonably heat-stable with a high dielectric constant. The primary uses of these products were in transformers, capacitors, hydraulic systems, and heat-transfer sinks. In the United States, the largest producer of PCBs was the Monsanto Company which produced PCBs under the trade name of Aroclor.

The Aroclor products are designated by a numbering code which reflects the number of carbons in the parent compound and the percentage by weight of chlorine. For example, Aroclor 1254 would contain a biphenyl as its parent compound and 54 percent chlorine by weight. The production of PCBs was voluntarily stopped in the United States in 1971 except for use in closed electrical systems. Due to the fact that PCBs exhibit lipophilic and hydrophobic properties in aqueous environments, they ultimately accumulate in the lipid of biota.

The revised edition of Water Quality Criteria recommends that, for the protection of predatory fish and wildlife, residues of PCB should not exceed 0.5 ug/g or 500 ug/Kg in whole fish (EPA, 1972). The FDA uses the limit of 2000 ug/Kg as its action level in edible fish tissue (Federal Register, 1984). PCBs are included in the EPA's priority pollutant list.

Pentachlorophenol (PCP)

PCP is a multi-purpose chemical that is used as a fungicide, algicide, bactericide, herbicide, and an insecticide. Its primary application is as a preservative in wood products. PCP is produced by the chlorination of a phenol molecule and is only slightly soluble in water; 14 mg/L at 20°C (Weast, 1975). It is believed that PCPs are excreted rapidly by fish, with half-lives in tissue being less than 24 hours (Lech, et al., 1978). PCP can enter the aquatic environment via the manufacturing and wood-preserving sites as well as leachate from treated wood products. Pentachlorophenol is listed on the EPA priority pollutant list and was banned from sale to the public in 1984.

INDIVIDUAL SITE EVALUATION

The following individual site evaluations are based on information obtained from the 1984 BWMP fish tissue and sediment sampling program. These evaluations should be used to provide insight into possible areas of concern but are based on a limited number of samples.

Wenatchee River at Wenatchee

Levels of arsenic, zinc, and DDT could be possible problem pollutants at this location. The fish tissue result for arsenic and zinc on a wet-weight basis were some of the highest found during the 1984 sampling.

The t-DDT concentration found in edible tissue samples (Bridgelip sucker) collected at this site ranked second highest on a lipid-normalized basis.

Lake Chelan

The pollutant of concern appears to be high levels of DDT. Lake Chelan has a substantially elevated availability of DDT based on the lipid weighted values for edible tissue. The TOC-corrected t-DDT sediment values also reflected the possibility of this elevated level.

Okanogan River below Malott

The results generated at this station appear to indicate elevated forms of DDT. On a wet-weight basis, bridgelip suckers collected in the river rank the highest found during the 1984 sampling. The lipid corrected value also shows this trend, but to a lesser extent. Sediment t-DDT results based on dry weight and TOC corrected both show Okanogan samples as having a moderately elevated level.

Columbia River at Northport

The primary concern at this location is elevated concentrations of several metals (lead, cadmium, copper, zinc). The edible fish tissue collected contained an average lead level of over 90 percent of the FDA unofficial guidelines for other food types. Sediment results also show possibly elevated metals and possible acid/base neutral problems.

Yakima River below Kiona

The Yakima River below Kiona shows possible signs of problems related to PCB and DDT forms. Liver tissue samples taken from both the predator and grazer species collected at this site showed the highest level of PCBs found in the 1984 sampling. The DDT problem is apparent from the high levels found in both the sediment and edible tissue sample. The sediment also shows elevated levels of phenol and 2-methyl phenol.

Yakima River at Birchfield Drain

The Yakima River at Birchfield Drain appears to have high levels of DDT forms and mercury. Edible tissue from Northern squawfish collected at this site showed the highest mercury value found during the 1984 sampling. DDT levels on a wet-weight basis and on a lipid-normalized basis appear to be moderate to elevated.

Skagit River below Mount Vernon

The only area of possible concern at this location is the level of pentachlorophenol in tissue samples from Bridgelip suckers. This level does not seem excessive on its own, but when compared to other levels found during 1984, it may indicate a problem.

Green/Duwamish above Allentown

The major areas of concern for this sample location are hexachlorocyclohexane (BHC), PCBs, and mercury. The BHC level found in edible tissue exceeds the NAS recommended level. The PCB level was the highest found in edible tissue during 1984. Mercury levels, though not the highest found in the state during 1984, appear to be elevated.

Palouse River at Hooper

For those parameters analyzed for during the 1984 BWMP sampling program, the Palouse River at Hooper appears to have no elevated concentrations.

Walla Walla River below Warm Springs

Like the Palouse River at Hooper, the Walla Walla River below Warm Springs has no elevated concentrations for those parameters analyzed.

RECOMMENDATIONS

1. Sampling time should be coordinated to the extent possible to increase the likelihood of collecting samples before spawning occurs. This would help minimize the effect of lipid fluctuation in the aquatic biota due to spawning, which has a direct effect on the levels of pesticides, PCBs, and other lipophilic compounds stored within the organism. In practice, however, this may be impractical due to inconsistencies among the life cycles of the projected sample species. Therefore, a compromise must be

reached between ability to obtain samples and sexual maturation differences among sample species. Taking these variables into consideration, May and June are the best months to sample, with July and August also being acceptable.

2. Guidelines are needed which identify concentrations worthy of additional investigation, one possibility being a percentile comparison of existing levels to those found to date in the BWMP program. For example, if one level exceeds a predetermined percentile, it could be flagged for appropriate action. The 50th percentile could be labeled elevated and warrant re-sampling. The 75th percentile could be moderate and signal an alert to the Ecology regional office. Samples that exceed the 95th percentile could denote an extreme level and justify, upon verification, a more in-depth investigation.

3. Sample site(s) with elevated levels should be sampled for three consecutive years to help establish ranges of data and confirm findings.

4. Effort should be made to establish uniform collection and analysis techniques that will allow year-to-year comparisons.

5. Data generated on lipophilic compounds should be presented both as wet-weight values and lipid-corrected. Lipid-weight values are known to substantially decrease variability between individuals and to facilitate cross-station comparisons. Wet-weight values should not be eliminated because there are limitations inherent to lipid-weight values; the most evident being the lack of criteria.

6. Gill tissue analysis should be eliminated due to lack of established guidelines and minimal sample weight per individual.

7. The sampling program should be expanded to facilitate a broader coverage of the state on a year-to-year basis.

8. Saltwater stations should be added with a goal toward expansion as the opportunity presents itself.

9. In consideration of the lack of sediment criteria, sediment sampling should be used as a preliminary indicator of a possible problem area and be replaced by an alternate method if values warrant a more intensive investigation. A second year of sediment sampling is needed to adequately evaluate the utility of using this approach for environmental monitoring in streams.

10. Four of the stations sampled during 1984 should be sampled again in 1985: Columbia River at Northport, Wenatchee River at Wenatchee, Okanogan River below Malott, and Green/Duwamish River above Allentown. These stations exhibited elevated levels of pollutants and require confirmation.

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APPENDIX I

Results of BWMP Fish and Shellfish Tissue Analysis - Wet Weight Basis (ug/Kg w.w.)

Location & Station No.	Collection Date	Organism	Tissue	Percent Lipids	Percent Solids	Aldrin	Dieldrin	Endrin	Chlordane: Alpha-cis	Chlordane: Gamma-trans	Chlordane: cis-nonachlor	Chlordane: trans-nonachlor	DDE, DDD, DDT: o,p'-DDE	p,p'-DDE	o,p'-DDD	p,p'-DDD	o,p'-DDT	p,p'-DDT	Total DDT Forms	Hexa-chloro-benzene
FRESHWATER																				
Skagit River at Mt. Vernon	8/30/82	Bridgelip Sucker	Whole		21[22.9]	<1	<1	<1	<1	<1	<1	<1	<1	12	<1	<1	<1	<1	12	<1
03A060	8/30/82	Bridgelip Sucker	Gill		28															
	8/30/82	Mountain Whitefish	Whole		28[26.1]	<1	<1	<1	<1	<1	<1	<1	<1	16	<1	<1	<1	<1	16	<1
Skagit River at Concrete	8/23/83	Bridgelip Sucker	Edible	.4	22.1	<1	<1	<1	<1	<1	<1	<1	<1	1.4	<1	<1	<1	<1	1.4	<1
04A060	8/23/83	Bridgelip Sucker	Viscera	1.5	24.0	<1	<1	<1	<1	<1	<1	<1	<1	5.3	<1	1.0	<1	<1	9.3	<1
	8/23/83	Bridgelip Sucker	Whole	.8	22.7	<1	<1	<1	<1	<1	<1	<1	<1	2.8	<1	<2	<1	<1	2.8	<1
	8/23/83	Bridgelip Sucker	Gill		16.1															
	8/23/83	Mountain Whitefish	Edible	3.9	28.0	<1	<1	<1	<1	<1	<1	<1	<1	8	<1	3	<1	8	19	<1
	8/23/83	Mountain Whitefish	Viscera	9.1	33.5	<1	<1	<1	<1	<1	<1	<1	<1	9.6	<1	5	<1	<1	14.6	<1
	8/23/83	Mountain Whitefish	Whole	5.3	29.4	<1	<1	<1	<1	<1	<1	<1	<1	8.4	<1	3.5	<1	<6.2	11.9	<1
	8/23/83	Mountain Whitefish	Gill		22[2]															
Snohomish River at Snohomish	8/30/82	Bridgelip Sucker	Whole		29[22.6]	<1	<1	<1	<1	<1	<1	<1	<1	37	<1	<1	<1	<1	37	<1
07A090	8/30/82	Bridgelip Sucker	Gill		23															
	8/30/82	Northern Squawfish	Whole		26[27.4]	<1	<1	<1	<1	<1	<1	<1	<1	26	<1	<1	<1	43	69	<1
	8/30/82	Northern Squawfish	Gill		27															
Cedar River near Landsburg	8/25/83	Rainbow Trout	Whole	6.7	24.6	<1	<1	<1	<1	<1	<1	<1	<1	4.3	<1	2.3	<1	3.8	10.4	<1
08C110	8/25/83	Rainbow Trout	Gill		21.1															
Green/Duwamish R. @ Allentown	8/24/83	Bridgelip Sucker	Whole	5.3	24.0	<1	<1	<1	<1	<1	<1	<1	<1	13	<1	<1	<1	<1	13	<1
09A060	8/24/83	Bridgelip Sucker	Gill		26.9															
Puyallup River at Puyallup	8/29/80	Largescale Sucker	Whole	5	25	<0.5	<0.1	<0.1	11	12	<0.5	<0.5	<0.5	35	<0.5	29	<0.5	<0.5	64	Int.
10A070	9/02/81	Largescale Sucker	Whole	3.9	31	<0.1	1.4	<0.1	4.0	7.1	<1	6.5	<0.1	28	<0.1	20	2.1	16	66	36
Hylebos Creek at Fife	8/24/83	Cutthroat Trout	Edible	4.2	21.8	<1	<1	<1	<1	<1	<1	<1	<1	75	<1	30	<1	43	148	<1
10G060	8/24/83	Cutthroat Trout	Viscera[6]	3.6	21.4	<1	<1	<1	<1	<1	<1	<1	<1	203	<1	116	<1	167	486	<1
	8/24/83	Cutthroat Trout	Whole	4.1	21.7	<1	<1	<1	<1	<1	<1	<1	<1	103	<1	49	<1	70	222	<1
	8/24/83	Cutthroat Trout	Gill		24[2]															
	8/24/83	Cutthroat Trout	Gill		24[7]															
Nisqually River at Nisqually	9/09/82	Mountain Whitefish	Whole		25[34.0]	<1	<1	<1	<1	<1	<1	<1	<1	10	<1	9	<1	17	36	<1
11A070	9/09/82	Mountain Whitefish	Gill		34															
	9/09/82	Bridgelip Sucker	Whole		26[30.1]	<1	<1	<1	<1	<1	<1	<1	<1	24	<1	11	<1	25	36	<1
	9/09/82	Bridgelip Sucker	Gill		29															
Chehalis River at Porter	9/18/79	Coast Range Sculpin	Whole	2	26	<0.1	<0.1	<0.1	1.6	1.3	0.7		<0.1	Int.	<0.1	0.1	<0.1	0.7	0.8	Int.
23A070	9/18/79	Pea Chub	Whole	6	31	<0.1	<0.1	<0.1	9.8	4.1	5.4		<0.1	60	<0.1	9.2	<0.1	<0.1	69	Int.
	9/29/80	Freshwater Mussels	Whole	0.4	16	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	0.3	Int.
	9/29/80	Squawfish	Whole	3	23	<0.5	<0.1	<0.1	1.4	<0.5	<0.5	4.6	<0.5	33	<0.5	3.4	<0.5	<0.5	36	Int.
	9/02/81	Largescale Sucker	Whole	3.1	31	<0.1	0.2	<0.1	2.9	2.6	1.1	2.8	<0.1	9.3	<0.1	1.8	<0.1	2.3	13	<20
	9/02/81	Squawfish	Whole	2.9	33	<0.1	0.5	<0.1	1.4	2.2	1.1	7.2	<0.1	16	<0.1	1.1	<0.1	<0.1	17	<20
Cowlitz River at Kelso	8/30/79	Coast Range Sculpin	Whole	3	25	<0.1	<0.1	<0.1	<0.1	<0.1	<1		<0.1	<0.1	<0.1	<0.1	<0.1	2.1	2.1	Int.
26B070	8/30/79	Largescale Sucker	Whole	0.4	19	<0.1	0.3	<0.1	<0.1	<0.1	<0.1		<0.1	25	<0.1	1.2	<0.1	2.9	29	Int.
	9/30/80	Largescale Sucker	Whole	9	29	<0.5	<0.1	<0.1	11	8.7	<0.5	<0.5	<0.5	110	22	67	<0.5	19	220	Int.
	9/02/81	Largescale Sucker	Whole	6.2	35	<0.1	1.0	<0.1	3.3	4.3	2.6	3.3	<0.1	32	<0.1	12	0.5	3.9	48	
Snake River at Burbank	9/18/80	Squawfish	Whole	4	25	<0.5	<0.1	<0.1	4.9	<0.5	<0.5	6.7	<0.5	240	<0.5	66	2	<0.5	310	Int.
33A050	9/18/80	Largescale Sucker	Whole	7	26	<0.5	<0.1	<0.1	8.3	5.3	<0.5	6.2	<0.5	310	<0.5	93	4.4	27	430	Int.
	8/20/81	Squawfish	Whole	6.8	35	<0.1	1.4	<0.1	<1	<1	<1	<1	<0.1	230	<0.1	46	<0.1	<0.1	280	<20
	8/20/81	Largescale Sucker	Whole	5.8	33	<0.1	1.9	<0.1	6.4	12	<1	<1	<0.1	99	<0.1	22	<0.1	19	140	<20
Palouse River at Hooper	9/27/78	Largescale Sucker	Whole	0.9	(27)	<0.1	81	<0.1	7	18		6	8	377	10	45	<0.1	70	500	33
34A070	9/27/78	Largescale Sucker	Liver	1	(25)	<0.1	126	<0.1	4	13		3	6	153	8	17	<0.1	25	210	32
	9/14/82	Bridgelip Sucker	Whole	1.7	26[28.5]	<1	<1	<1	<1	<1	<1	<1	<1	220	<1	36	<1	42	298	<1
	9/14/82	Bridgelip Sucker	Gill		22															
	9/14/82	Northern Squawfish	Whole	1.8	29[27.6]	<1	<1	<1	<1	<1	<1	<1	<1	660	<1	58	<1	40	758	<1
	9/14/82	Northern Squawfish	Gill		28															
Columbia River at Vernita	9/17/80	Squawfish	Whole	5	30	<0.5	<0.1	<0.1	4.1	<0.5	<0.5	7.0	<0.5	860	<0.5	120	<0.5	13	990	Int.
36A070	9/17/80	Largescale Sucker	Whole	7	28	<0.5	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	480	<0.5	6.5	<0.5	14	500	Int.
	8/20/81	Squawfish	Whole	2.5	33	<0.1	<0.1	<0.1	<1	<1	<1	<1	<0.1	140	<0.1	12	<0.1	<0.1	150	
	8/20/81	Largescale Sucker	Whole	2.3	30	<0.1	0.2	<0.1	6.0	2.6	<1	2.9	<0.1	38	<0.1	15	<0.1	3.2	56	<20
	9/01/83	Bridgelip Sucker	Whole	1.9	23.6	<1	<1	<1	<1	<1	<1	<1	<1	505	<1	107	<1	88	701	<1
	9/01/83	Bridgelip Sucker	Gill		22.1															
	9/01/83	Mountain Whitefish	Whole	13.8	36.5	<1	<1	<1	<1	<1	<1	<1	<1	732	<1	135	<1	121	988	<1
	9/01/83	Mountain Whitefish	Gill		33[2]															

Results of BWMP Fish and Shellfish Tissue Analysis - Wet Weight Basis (ug/Kg w.w.)

Location & Station No.	Collection Date	Organism	Tissue	Percent Lipids	Percent Solids	Penta-chloro-phenol	BHC Alpha	BHC Gamma	Methoxy-chlor	Arochlors (PCBs) 1221	1232	1242	1248	1254	1260	Total PCBs	Metals As	Cd	Cr	Cu	Hg	Pb	Zn
FRESHWATER																							
Skagit River at Mt. Vernon 03A060	8/30/82	Bridgelip Sucker	Whole		21[22.9]	<.1	3	<1	<10					47	<10	47	48	80	1,000	1,700	115	620	25,500
	8/30/82	Bridgelip Sucker	Gill		28												60	60	700	1,200	15	610	13,300
	8/30/82	Mountain Whitefish	Whole		28[26.1]	<0.1[3]	7	<1	<10					38	<10	38	50	20	900	1500	33	610	27,000
Skagit River at Concrete 04A060	8/23/83	Bridgelip Sucker	Edible	.4	22.1		<1	<1	<1					11	<10	11							
	8/23/83	Bridgelip Sucker	Viscera	1.5	24.0		2	<1	<1					<10	<10	<10							
	8/23/83	Bridgelip Sucker	Whole	.8	22.7		<1.4	<1	<1					<11	<10	<11	60	40	50	1,500	12	440	16,000
	8/23/83	Bridgelip Sucker	Gill		16.1																		
	8/23/83	Mountain Whitefish	Edible	3.9	28.0		6.3	<1	<1					38	<10	38							
	8/23/83	Mountain Whitefish	Viscera	9.1	33.5		8.6	<1	<1					<10	<10	<10							
	8/23/83	Mountain Whitefish	Whole	5.3	29.4		6.9	<1	<1					<31	<10	<31	30	50	520	1,300	59	530	22,000
	8/23/83	Mountain Whitefish	Gill		22[2]																		
Snohomish River at Snohomish 07A090	8/30/82	Bridgelip Sucker	Whole		29[22.6]	5.5	<1	<1	<10					240	<10	240	44	40	7,000	1,900	33	760	19,500
	8/30/82	Bridgelip Sucker	Gill		23												8	20	200	1,400	33	620	12,100
	8/30/82	Northern Squawfish	Whole		26[27.4]	5.9	5	<1	<10					320	<10	320	18	40	1,400	1,300	50	400	28,000
	8/30/82	Northern Squawfish	Gill		27												28	60	1,300	1,700	43	380	30,900
Cedar River near Landsburg 08C110	8/25/83	Rainbow Trout	Whole	5.7	24.6		1.9	<1	<1					12	<10	12	20	80	69	1,370	6	170	23,900
	8/25/83	Rainbow Trout	Gill		21.1																		
Green/Duwamish R. @ Allentown 09A060	8/24/83	Bridgelip Sucker	Whole	5.3	24.0		20	<1	<1					1,600	<10	1,600	90	30	520	1,400	44	800	14,000
	8/24/83	Bridgelip Sucker	Gill		26.9																		
Puyallup River at Puyallup 10A070	8/29/80	Largescale Sucker	Whole	5	25		4.6	0.6	<0.5							290							
	9/02/81	Largescale Sucker	Whole	3.9	31	<20	<0.1	<0.1	<0.1							160							
Hylebos Creek at Fife 10G060	8/24/83	Cutthroat Trout	Edible	4.2	21.8		1.9	<1	<1					<10	<10	<10							
	8/24/83	Cutthroat Trout	Viscera[6]	3.6	21.4		4.0	<1	<1					<10	<10	<10							
	8/24/83	Cutthroat Trout	Whole	4.1	21.7		2.4	<1	<1					<10	<10	<10	120	10	250	640	34	460	15,200
	8/24/83	Cutthroat Trout	Gill		24[2]												350	20	360	890	36	690	26,700
	8/24/83	Cutthroat Trout	Gill		24[7]																		
Nisqually River at Nisqually 11A070	9/09/82	Mountain Whitefish	Whole		25[34.0]	5.4	4	<1	<10					<10	<10	<10	42	<20	100	1,200	75	1,140	17,600
	9/09/82	Mountain Whitefish	Gill		34												22	20	1,100	1,500	40	690	25,400
	9/09/82	Bridgelip Sucker	Whole		26[30.1]	3.7	15	<1	<10					<10	<10	<10	4	60	800	1,700	93	510	27,800
	9/09/82	Bridgelip Sucker	Gill		29												2	40	700	1,300	40	430	18,500
Chehalis River at Porter 23A070	9/18/79	Coast Range Sculpin	Whole	2	26		0.7	<0.1	<1							31		120	500	1,300	<25	1,700	23,000
	9/18/79	Pea Chub	Whole	6	31		2.4	<0.1	<10							390							
	9/29/80	Freshwater Mussels	Whole	0.4	16		<0.1	<0.1	<0.1							2		80	300	2,100	23	560	13,000
	9/29/80	Squawfish	Whole	3	23		0.6	<0.5	<0.5							130		75	280	1,800	120	1,400	17,000
	9/02/81	Largescale Sucker	Whole	3.1	31	<20	<0.1	<0.1	<0.1							38							
	9/02/81	Squawfish	Whole	2.9	33	<20	<0.1	<0.1	<0.1							75							
Cowlitz River at Kelso 26B070	8/30/79	Coast Range Sculpin	Whole	3	25		1	<0.1	<1							51		160	1,740	1,800	<26	2,400	26,000
	8/30/79	Largescale Sucker	Whole	0.4	19		0.1	<0.1	<1							210		82	300	1,150	<27	1,770	17,200
	9/30/80	Largescale Sucker	Whole	9	29		4.5	<0.5	<0.5							250							
	9/02/81	Largescale Sucker	Whole	6.2	35	50	<0.1	<0.1	<0.1							100							
Snake River at Burbank 33A050	9/18/80	Squawfish	Whole	4	25		1.6	<0.5	<0.5							76		170	580	1,200	75	2,540	22,000
	9/18/80	Largescale Sucker	Whole	7	26		2.8	0.3	<0.5							100		150	740	1,040	32	1,570	20,000
	8/20/81	Squawfish	Whole	6.8	35	<20	<0.1	<0.1	<0.1							120							
	8/20/81	Largescale Sucker	Whole	5.8	33	<20	<0.1	<0.1	<0.1							81							
Palouse River at Hooper 34A070	9/27/78	Largescale Sucker	Whole	0.9	(27)				<0.1							<0.1							
	9/27/78	Largescale Sucker	Liver	1	(25)				<0.1							<0.1							
	9/14/82	Bridgelip Sucker	Whole	1.7	26[28.5]	2.9	7	<1	<10					<10	<10	<10	58	40	500	1,200	40	470	20,600
	9/14/82	Bridgelip Sucker	Gill		22												50	40	100	1,400	13	620	30,200
	9/14/82	Northern Squawfish	Whole	1.8	29[27.6]	2.7	490	<1	<10					<10	<10	<10	64	<20	700	1,900	195	420	22,200
	9/14/82	Northern Squawfish	Gill		28												64	40	100	1,700	73	660	20,400
Columbia River at Vernita 36A070	9/17/80	Squawfish	Whole	5	30		3.1	0.5	<0.5							400		150	180	1,360	<30	1,540	29,200
	9/17/80	Largescale Sucker	Whole	7	28		2.4	<0.5	<0.5							120	960	310	620	1,900	31	2,600	56,600
	8/20/81	Squawfish	Whole	2.5	33	<20	<0.1	<0.1	<0.1							120							
	8/20/81	Largescale Sucker	Whole	2.3	30	<20	<0.1	<0.1	<0.1							50							
	9/01/83	Bridgelip Sucker	Whole	1.9	23.6		5.5	<1	<1					336	<10	336	10	75	127	737	8	1,030	17,700
	9/01/83	Bridgelip Sucker	Gill		22.1		59	<1	<1					338	<10	338	20	126	<16	685	20	110	21,300
	9/01/83	Mountain Whitefish	Whole	13.8	36.5																		
	9/01/83	Mountain Whitefish	Gill		33[2]																		

Results of [illegible] Fish and Shellfish Tissue Analysis - Wet Weight Basis (ug/kg w.w.)

Location & Station No.	Collection Date	Organism	Tissue	Percent Lipids	Percent Solids	Aldrin	Dieldrin	Endrin	Chlordane: Alpha-cis	Chlordane: Gamma-trans	Chlordane: cis-nonachlor	Chlordane: trans-nonachlor	DDE, DDD, DDT: o,p'-DDE	p,p'-DDE	o,p'-DDD	p,p'-DDD	o,p'-DDT	p,p'-DDT	Total DDT Forms	Hexachlorobenzene
FRESHWATER																				
Yakima River at Kiona 37A090	9/16/80	Smallmouth Bass	Whole	3	28	<0.5	<0.1	<0.1	6.0	<0.5	<0.5	6.6	<0.5	460	<0.5	76	<23*	40	580	Int.
	9/16/80	Bridgelip Sucker	Whole	7	29	<0.5	<0.1	<0.1	21	9.2	<0.5	<0.5	<0.5	670	<0.5	170	<45*	57	900	Int.
	8/20/81	Squawfish	Whole	7.4	37	<0.1	48	0.7	93	5.1	32	9.8	<0.1	1,100	<0.1	110	<0.1	47	1,260	
	8/20/81	Largescale Sucker	Whole	13	45	<0.1	76	0.5	230	17	73	<1	<0.1	2,100	<0.1	390	<0.1	590	3,080	
Yakima River 10 miles below Kiona 37A090[1]	9/16/82	Bridgelip Sucker	Whole	[8.6]	2?[30.0]	<1	<1	<1	<1	<1	<1	<1	<1	2,040	<1	290	<1	380	2,710	<1
	9/16/82	Bridgelip Sucker	Gill		20															
	9/16/82	Mountain Whitefish	Whole	[8.1]	37[32.8]	<1	<1	<1	<1	<1	<1	<1	<1	1,020	<1	190	<1	220	1,430	<1
	9/16/82	Mountain Whitefish	Gill		(25)															
	9/01/83	Bridgelip Sucker	Whole	10.4	28.5	<1	<1	<1	<1	<1	<1	<1	<1	1.268	<1	176	<1	354	1,798	<1
	9/01/83	Bridgelip Sucker	Gill		20.2															
	9/01/83	Channel Catfish	Whole	14.6	30.5	<1	<1	<1	<1	<1	<1	<1	<1	2,365	<1	233	<1	391	2,989	<1
	9/01/83	Channel Catfish	Gill		22.3															
Yakima River below Birchfield Drain	9/02/83	Bridgelip Sucker	Edible	4.5	22.1	<1	<1	<1	<1	<1	<1	<1	<1	1,847	<1	280	<1	669	2,796	<1
	9/02/83	Bridgelip Sucker	Viscera	6.4	31.7	<1	<1	<1	<1	<1	<1	<1	<1	6,728	<1	2,059	<1	1,009	9,796	<1
	9/02/83	Bridgelip Sucker	Whole	5.1	25.2	<1	<1	<1	<1	<1	<1	<1	<1	3,433	<1	858	<1	780	5,071	<1
	9/02/83	Bridgelip Sucker	Gill		21.1															
	9/02/83	Mountain Whitefish	Edible	11.2	31.6	<1	<1	<1	<1	<1	<1	<1	<1	469	<1	110	<1	235	814	<1
	9/02/83	Mountain Whitefish	Viscera	3.3	33.4	<1	<1	<1	<1	<1	<1	<1	<1	932	<1	244	<1	570	1,746	<1
	9/02/83	Mountain Whitefish	Whole	9.1	32	<1	<1	<1	<1	<1	<1	<1	<1	578	<1	141	<1	314	1,033	<1
	9/02/83	Mountain Whitefish	Gill		26.3															
	9/02/83	Northern Squawfish	Whole	0.6	27.1	<1	<1	<1	<1	<1	<1	<1	<1	2,157	<1	252	<1	131	2,540	<1
	9/02/83	Northern Squawfish	Gill		26.2															
Wenatchee River at Wenatchee 45A070	9/15/82	Bridgelip Sucker	Whole		22[21.7]	<1	<1	<1	<1	<1	<1	<1	<1	296	<1	52	<1	61	409	<1
	9/15/82	Bridgelip Sucker	Gill		(25)															
	9/15/82	Mountain Whitefish	Whole		32[27.1]	<1	<1	<1	<1	<1	<1	<1	<1	480	<1	107	<1	72	559	<1
	9/15/82	Mountain Whitefish	Gill		(25)															
Lake Chelan Outlet Dam 47A070	9/15/82	Bridgelip Sucker	Whole		22[26.0]	<1	<1	<1	<1	<1	<1	<1	<1	3,200	<1	850	<1	418	4,470	<1
	9/15/82	Bridgelip Sucker	Gill		20															
	9/15/82	Northern Squawfish	Whole		24[25.2]	<1	<1	<1	<1	<1	<1	<1	<1	1,380	<1	104	<1	48	1,530	<1
	9/15/82	Northern Squawfish	Gill		(25)															
	8/29/83	Bridgelip Sucker	Edible	4.8	22.6	<1	<1	<1	<1	<1	<1	<1	<1	473	<1	193	<1	113	779	<1
	8/29/83	Bridgelip Sucker	Viscera	2.0	23.4	<1	<1	<1	<1	<1	<1	<1	<1	2,779	<1	1,211	<1	201	4,191	<1
	8/29/83	Bridgelip Sucker	Whole	3.9	22.8	<1	<1	<1	<1	<1	<1	<1	<1	1,189	<1	510	<1	140	1,839	<1
	8/29/83	Bridgelip Sucker	Gill		14.8															
	8/29/83	Squawfish	Edible	6.9	32.1	<1	<1	<1	<1	<1	<1	<1	<1	1,709	<1	97	<1	21	460	<1
	8/29/83	Squawfish	Viscera	5.8	26.0	<1	<1	<1	<1	<1	<1	<1	<1	432	<1	28	<1	<1	1,827	<1
	8/29/83	Squawfish	Whole	6.6	30.3	<1	<1	<1	<1	<1	<1	<1	<1	1,339	<1	77	<1	<15	1,416	<1
	8/29/83	Squawfish	Gill		[26.3]															
Okanogan River at Okanogan 49A090	8/29/83	Bridgelip Sucker	Whole	2.1	26.7	<1	<1	<1	<1	<1	<1	<1	<1	1,399	<1	241	<1	144	1,784	<1
	8/29/83	Bridgelip Sucker	Gill		25.0															
	8/29/83	Mountain Whitefish	Whole	8.3	30.1	<1	<1	<1	<1	<1	<1	<1	<1	642	<1	115	<1	54	811	<1
	8/29/83	Mountain Whitefish	Gill		26.5															
Spokane River at Riverside State Park 54A120	9/23/80	Squawfish	Whole	4	26	<0.5	<0.1	<0.1	6.1	<0.5	5.5	10	<0.5	130	<0.5	10	<0.5	<0.5	140	Int.
	9/23/80	Largescale Sucker	Whole	0.4	21	<0.5	0.3	<0.1	0.9	<0.5	<0.5	0.9	<0.5	15	<0.5	1.9	<0.5	<0.5	17	Int.
	8/04/81	Squawfish	Whole	12	34	<0.1	2.1	1.8	3.7	<1	1.1	7.1	<0.1	34	<0.1	1.3	<0.1	<0.1	35	
	8/04/81	Largescale Sucker	Whole	5.2	31	<0.1	1.9	<0.1	3.8	5.8	3.1	4.3	<0.1	30	<0.1	2.7	<0.1	6.3	39	<20
	9/13/82	Bridgelip Sucker	Whole	[.67]	22[22.1]	<1	<1	<1	<1	<1	<1	<1	<1	70	<1	<1	<1	<1	70	<1
	9/13/82	Bridgelip Sucker	Gill		(25)															
	9/13/82	Northern Squawfish	Whole	[1.2]	26[25.7]	<1	<1	<1	<1	<1	<1	<1	<1	120	<1	<1	<1	<1	120	<1
	9/13/82	Northern Squawfish	Gill		(25)															
	8/31/83	Bridgelip Sucker	Edible[3]	4.0	21.4	<1	<1	<1	<1	<1	<1	<1	<1	44	<1	37	<1	86	167	<1
	8/31/83	Bridgelip Sucker	Viscera[4]	8.4	27.6	<1	<1	<1	<1	<1	<1	<1	<1	60	<1	<1	<1	<10	60	<1
	8/31/83	Bridgelip Sucker	Whole[5]	5.3	23.3	<1	<1	<1	<1	<1	<1	<1	<1	49	<1	<26	<1	<63	49	<1
	8/31/83	Bridgelip Sucker	Gill		20.3															
	8/31/83	Mountain Whitefish	Edible	8.6	30.0	<1	<1	<1	<1	<1	1	<1	<1	44	<1	<1	<1	<1	44	<1
	8/31/83	Mountain Whitefish	Viscera	11.7	4?.5	<1	<1	<1	<1	<1	<1	<1	<1	95	<1	<1	<1	<10	95	<1
	8/31/83	Mountain Whitefish	Whole	9.3	3?.3	<1	<1	<1	<1	<1	<1	<1	<1	56	<1	<1	<1	<3	56	<1
	8/31/83	Mountain Whitefish	Gill		32.0[2]															
Spokane River at River Mile 87.4	9/01/83	Longnose Sucker	Whole	2.5	21.1	<1	<1	<1	<1	<1	<1	<1	<1	8.2	<1	<1	<1	<1	8.2	<1
	9/01/83	Longnose Sucker	Whole	5.8	22.3	<1	<1	<1	<1	<1	<1	<1	<1	11	<1	<1	<1	<1	11	<1
	9/01/83	Cutthroat Trout	Edible		[21.1]															
	9/01/83	Cutthroat Trout	Gill		[21.1]															
Spokane River at River Mile 86.8	9/01/83	Longnose Sucker	Whole	3.2	21.3	<1	<1	<1	<1	<1	<1	<1	<1	16	<1	<1	<1	<1	16	<1
	9/01/83	Longnose Sucker	Whole		[21.3]															

Results of BWMP Fish and Shellfish Tissue Analysis - Wet Weight Basis

Location & Station No.	Collection Date	Organism	Tissue	Percent Lipids	Percent Solids	Pentachlorophenol	BHC Alpha	BHC Gamma	Methoxychlor	Arochlors (PCBs) 1221	1232	1242	1248	1254	1260	Total PCBs	Metals As	Cd	Cr	Cu	Hg	Pb	Zn
FRESHWATER																							
Yakima River at Kiona 37A090	9/16/80	Smallmouth Bass	Whole	3	28		3.7	0.3	<0.5							50		110	260	940	<29	1,260	20,300
	9/16/80	Bridgelip Sucker	Whole	7	29		3.4	0.6	<0.5							120		55	270	1,200	<27	660	14,300
	8/20/81	Squawfish	Whole	7.4	37	<20	<0.1	<0.1	<0.1							160							
	8/20/81	Largescale Sucker	Whole	13	45		<0.1	<0.1	<0.1							410							
Yakima River 10 miles below Kiona 37A090[1]	9/16/82	Bridgelip Sucker	Whole	[8.6]	27[30.0]	2.8	6	<1	<10					<10	<10	<10	38	80	500	1,900	95	670	25,400
	9/16/82	Bridgelip Sucker	Gill		20												28	<20	<100	1,500	35	520	15,900
	9/16/82	Mountain Whitefish	Whole	[3.1]	37[32.8]	2.7	6	<1	<10					<10	<10	<10	32	60	600	1,100	23	480	21,200
	9/16/82	Mountain Whitefish	Gill		(25)												34	20	100	1,100	48	750	16,700
	9/01/83	Bridgelip Sucker	Whole	10.4	28.5		9	<1	<1					346	<10	346							
	9/01/83	Bridgelip Sucker	Gill		20.2												<20	10	110	870	20	510	16,400
	9/01/83	Channel Catfish	Whole	14.6	30.5		9	<1	<1					746	<10	746							
	9/01/83	Channel Catfish	Gill		22.3												<20	10	200	740	16	630	19,300
Yakima River below Birchfield Drain	9/02/83	Bridgelip Sucker	Edible	4.5	22.1		3.9	<1	<1					296	<10	296							
	9/02/83	Bridgelip Sucker	Viscera	6.4	31.7		14	<1	<1					1,250	<100	1,250							
	9/02/83	Bridgelip Sucker	Whole	5.1	25.2		7.2	<1	<1					606	<89	606							
	9/02/83	Bridgelip Sucker	Gill		21.1												20	10	50	1,300	13	570	16,000
	9/02/83	Mountain Whitefish	Edible	11.2	31.6		13	<1	<1					128	<10	128							
	9/02/83	Mountain Whitefish	Viscera	3.3	33.4		22	<1	<1					297	<10	297							
	9/02/83	Mountain Whitefish	Whole	9.1	32		15	<1	<1					168	<10	168							
	9/02/83	Mountain Whitefish	Gill		26.3												40	10	90	1,100	74	690	23,000
	9/02/83	Northern Squawfish	Whole	0.8	27.1		5.5	<1	<1					510	<10	510							
	9/02/83	Northern Squawfish	Gill		26.2												40	10	110	1,700	191	770	30,000
Wenatchee River at Wenatchee 45A070	9/15/82	Bridgelip Sucker	Whole		22[21.7]	1.5	4	<1	<10					<10	<10	<10	62	160	300	1,600	23	1,040	38,400
	9/15/82	Bridgelip Sucker	Gill		(25)												28	140	100	1,300	Ins.	1,360	29,900
	9/15/82	Mountain Whitefish	Whole		32[27.1]	1.9	10	<1	<10					<10	<10	<10	50	140	2,000	1,300	23	1,090	25,900
	9/15/82	Mountain Whitefish	Gill		(25)												116	100	100	1,300	Ins.	1,220	27,900
Lake Chelan Outlet Dam 47A070	9/15/82	Bridgelip Sucker	Whole		22[26.0]	2.6	7	<1	<10					<10	<10	<10	62	160	300	1,300	30	950	30,400
	9/15/82	Bridgelip Sucker	Gill		20												46	80	<200	1,000	3	1,140	15,400
	9/15/82	Northern Squawfish	Whole		24[25.2]	2.5	5	<1	<10					<10	<10	<10	32	80	100	1,900	10	530	32,100
	9/15/82	Northern Squawfish	Gill		(25)												80	180	100	2,000	Ins.	1,420	32,700
	8/29/83	Bridgelip Sucker	Edible	4.8	22.6		4.5	<1	<1					29	<10	29							
	8/29/83	Bridgelip Sucker	Viscera	2.0	23.4		3.9	<1	<1					131	<10	131							
	8/29/83	Bridgelip Sucker	Whole	3.9	22.8		4.3	<1	<1					61	<10	61							
	8/29/83	Bridgelip Sucker	Gill		14.8												<10	60	320	1,400	2	890	16,000
	8/29/83	Squawfish	Edible	6.9	32.1		6.7	<1	<1					114	<10	114							
	8/29/83	Squawfish	Viscera	5.8	26.0		<1	<1	<1					38	<10	38							
	8/29/83	Squawfish	Whole	6.6	30.3		<5	<1	<1					92	<10	92							
	8/29/83	Squawfish	Gill		[26.0]												50	90	50	1,400	10	730	35,000
Okanogan River at Okanogan 49A090	8/29/83	Bridgelip Sucker	Whole	2.1	26.7		5.3	<1	<1					583	<10	583							
	8/29/83	Bridgelip Sucker	Gill		25.0												50	50	100	1,100	5	710	19,000
	8/29/83	Mountain Whitefish	Whole	8.3	30.1		34	<1	<1					122	<10	122							
	8/29/83	Mountain Whitefish	Gill		26.5												<10	100	120	1,300	27	1,160	28,000
Spokane River at Riverside State Park 54A120	9/20/80	Squawfish	Whole	4	26		1.6	0.3	<0.5							1,200		300	220	1,020	<22	1,400	24,000
	9/20/80	Largescale Sucker	Whole	0.4	21		0.5	<0.5	<0.5							230		380	540	1,600	<23	3,600	54,000
	8/04/81	Squawfish	Whole	12	34	140	<0.1	<0.1	<0.1							160							
	8/04/81	Largescale Sucker	Whole	5.2	31	<20	<0.1	<0.1	<0.1							160							
	9/13/82	Bridgelip Sucker	Whole	[.67]	22[22.1]	8.9	2	<1	<10					200	300	500	46	260	500	1,400	20	1,720	47,700
	9/13/82	Bridgelip Sucker	Gill		(25)												60	120	100	1,600	8	1,670	60,400
	9/13/82	Northern Squawfish	Whole	[1.7]	26[25.7]	3.2	3	<1	<10					1,400	890	2,300	56	220	500	1,500	58	740	27,000
	9/13/82	Northern Squawfish	Gill		(25)												70	840	100	1,400	Ins.	1,100	27,900
	8/31/83	Bridgelip Sucker	Edible[3]	4.0	21.4		5	<1	<1					369	<10	369							
	8/31/83	Bridgelip Sucker	Viscera[4]	8.4	27.6		25	<1	<1					1,464	<10	1,464							
	8/31/83	Bridgelip Sucker	Whole[5]	5.3	23.3		11	<1	<1					697	<10	697							
	8/31/83	Bridgelip Sucker	Gill		20.3												20	160	180	940	13	1,860	30,100
	8/31/83	Mountain Whitefish	Edible	8.6	36.0		31	<1	<1					276	<10	276							
	8/31/83	Mountain Whitefish	Viscera	11.7	41.5		59	<1	<1					424	<10	424							
	8/31/83	Mountain Whitefish	Whole	9.3	37.3		38	<1	<1					273	<10	273							
	8/31/83	Mountain Whitefish	Gill		32.0[2]												<20	310	120	1,100	15	1,200	28,800
Spokane River at River Mile 87.4	9/01/83	Longnose Sucker	Whole	2.5	21.1		1.7	<1	<1					93	<10	93	150	559	164	1,280	7	2,190	77,100
	9/01/83	Longnose Sucker	Whole	5.8	22.3		<1	<1	<1					36	<10	36							
	9/01/83	Cutthroat Trout	Edible		[21.1]												<20	316	66	4,960	13	680	60,400
	9/01/83	Cutthroat Trout	Gill		[21.1]												<20	1,150	73	1,060	7	1,990	195,300
Spokane River at River Mile 86.8	9/01/83	Longnose Sucker	Whole	3.2	21.3		5	<1	<1					270	<10	270							
	9/01/83	Longnose Sucker.	Whole		[21.3]												130	429	66	7,590	6	1,320	61,600

Results of BWMP Fish and Shellfish Tissue Analysis - Wet Weight Basis (ug/Kg w.w.)

Location & Station No.	Collection Date	Organism	Tissue	Percent Lipids	Percent Solids	Aldrin	Dieldrin	Endrin	Chlordane: Alpha-cis	Chlordane: Gamma-trans	Chlordane: cis-nonachlor	Chlordane: trans-nonachlor	DDE + DDD + DDT: o,p'-DDE	p,p'-DDE	o,p'-DDD	p,p'-DDD	o,p'-DDT	p,p'-DDT	Total DDT Forms	Hexa-chloro-benzene
FRESHWATER																				
Kettle River at Barstow 60A070	9/13/82	Bridgelip Sucker	Whole		26[23.6]	<1	<1	<1	<1	<1	<1	<1	<1	59	<1	22	<1	35	57	<1
	9/13/82	Mountain Whitefish	Whole		32[33.7]	<1	<1	<1	<1	<1	<1	<1	<1	67	<1	36	<1	15	51	<1
	9/13/82	Mountain Whitefish	Gill		(25)															
SALTWATER																				
Hood Canal at Pulali Point HCB002	9/06/79	Bay Mussel	Whole	2	23	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		
	8/25/80	Bay Mussel	Whole	0.45	9.3	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		<1
	7/28/81	Bay Mussel	Whole	0.65	6.3	<1	<1	<1	<1	<1	<1	<1		2		<1	-	<1	2	<1
Case Inlet off Herron Island CSED01	8/10/80	Bay Mussel	Whole	0.94	12.7	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		<1
	7/29/81	Bay Mussel	Whole	0.86	12.3	<1	<1	<1	<1	<1	<1	<1		2.4		4.4		1.7	8.5	<1
Carr Inlet - CRR001	7/10/80	Bay Mussel	Whole	1.43	16.1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		<1
Port Susan at Kayak Point SU2001	7/09/80	Bay Mussel	Whole	0.47	12.6	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		<1
	9/29/81	Bay Mussel	Whole	0.76	11.8	<1	<1	<1	<1	<1	<1	<1		1.2		1.2		1.2	3.6	<1
Commencement Bay - Mouth of City Waterway CMB006	7/30/81	Bay Mussel	Whole	0.68	8.7	<1	<1	<1	<1	<1	<1	<1		1.5		2.5		2.8	6.8	<1
	12/01/82	Bay Mussel	Whole	0.13	7.0	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

Location & Station No.	Collection Date	Organism	Tissue	Percent Lipids	Percent Solids	Penta-chloro-phenol	BHC: Alpha	BHC: Gamma	Methoxy-chlor	Arochlors (PCBs): 1221	1232	1242	1248	1254	1260	Total PCBs	Metals: As	Cd	Cr	Cu	Hg	Pb	Zn
FRESHWATER																							
Kettle River at Barstow 60A070	9/13/82	Bridgelip Sucker	Whole		26[23.6]	2.5	2	<1	<10					<10	<10	<10	62	100	400	1,200	38	750	27,100
	9/13/82	Mountain Whitefish	Whole		32[33.7]	4.1	36	<1	<10					<10	<10	<10	64	80	1,100	1,600	20	620	21,700
	9/13/82	Mountain Whitefish	Gill		(25)												56	40	100	800	Ins.	640	34,800
SALTWATER																							
Hood Canal at Pulali Point HCB002	9/06/79	Bay Mussel	Whole	2	23		0.9	<0.1	<1							7.4	600	3,910	480	4,140		310	
	8/25/80	Bay Mussel	Whole	0.45	9.3		<1	<1	<1	<5	<5	<5	<5	<5	<5		96	980	92	1,120		160	
	7/28/81	Bay Mussel	Whole	0.65	6.3	<1	<1	<1		<10	<10	<10	<10	<10	<10		320	770	140	1,300	5	260	13,400
Case Inlet off Herron Island CSE001	8/10/80	Bay Mussel	Whole	0.94	12.7		<1	<1	<1	<5	<5	71	<5	61	<5	132	210	450	91	890		160	
	7/29/81	Bay Mussel	Whole	0.86	12.3	2	1.3	<1		<10	<10	<10	<10	26	<10	26	500	1,800	150	1,600	5	270	15,600
Carr Inlet - CRR001	7/10/80	Bay Mussel	Whole	1.43	16.1		<1	<1	<1	<5	<5	<5	<5	<5	111	111	120	950	130	1,130		210	
Port Susan at Kayak Point SU2001	7/09/80	Bay Mussel	Whole	0.47	12.6		<1	<1	<1	<5	<5	<5	<5	93	<5	93	120	450	110	760		230	
	9/29/81	Bay Mussel	Whole	0.76	11.8	<1	<1	<1		<10	<10	<10	<10	15	<10	15	420	400	280	1,800	6	430	16,200
Commencement Bay - Mouth of City Waterway CMB006	7/30/81	Bay Mussel	Whole	0.68	8.7	5	3.6	<1		<10	<10	<10	<10	82	<10	82	500	500	420	4,000	14	3,800	43,000
	12/01/82	Bay Mussel	Whole	0.13	7.0	5.1	<1	<1	<10					26	<10	<26	150	60	100	1,100	15	250	21,700

Int. = Interference.
Ins. = Insufficient sample for analysis.
( ) = Percent solids estimated, not measured.
[ ] = Percent solids from pesticides analyses.
* = Interference; increased detection limits.

1 Nearest BWMP sample station, fish collected at nearest accessible point.
2 Less than 5 grams of tissue were available for analysis.
3 Edible portion = fillet plus skin tissue.
4 Viscera portion = head, gills, viscera, and everything else excluding tissues in 3, above.
5 Whole fish = combined ratios of 3 and 4, above, using percent solids data from each.
6 Viscera portion = same as 4, above, without the head.
7 Percent solids from previous gill sample; insufficient sample for analysis.

APPENDIX II

SAMPLE SITE DESCRIPTIONS FOR THE 1984 BWMP FISH TISSUE AND SEDIMENT COLLECTION

Lake Chelan - Near the lake's outlet along both banks.

Columbia River at Northport - From the pool under the Highway 25 bridge to the riffle 1/4 mile upstream.

Okanogan River Below Malott - The slow-moving waters approximately 5 miles downstream from Malott (total sample area approximately 1/4 river mile).

Palouse River at Hooper - Both the upstream and downstream riffles located below Hooper.

Walla Walla River Below Warm Springs - Near the wooden Cummins Road bridge in both the upstream and downstream riffles.

Yakima River Ten Miles Below Kiona - Approximately one mile upstream from Horn Rapids (at the first deep riffle area), extending downstream for about 1/4 mile.

Yakima River at Birchfield Drain - From about 200 feet upstream into the mixing area of the drain and Yakima River downstream to the confluence with the Yakima River.

Skagit River Below Mount Vernon - From about 1/4 mile downstream from Mount Vernon (from the sewage outfall) to the sand bar 400 yards downstream.

Green/Duwamish River Above Allentown - One quarter mile upstream from I-5 bridge along the golf course on the southwest bank.

Wenatchee River at Wenatchee - The first riffle area upstream from the mouth, under the Highway 97 bridge, and downstream approximately 200 yards.

APPENDIX III

ne surrogate pesticide Heptachlor was added to each tissue sample before xtraction. Full recovery of the pesticide reflects a competent extraction f the surrogate only. The recovery data were not used to correct reported alues of other pesticides quantified.

SURROGATE RECOVERY BWMP 1984

Sample Number	Surrogate Recovery (percent)
Reagent Blank	98
37500	97
37501	106
37502	107
37503	98
37504	96
37505	108
37506	97
37507	65
37508	119
37509	104
37510	108
37511	111
37512	84
37513	93
37514	96
37515	102
37516	I
37517	103
37518	I
37519	95
37520	111
37521	98
38538	113
38539	96
38540	103
38541	96
38542	96
38543	91
36540	I
36541	I
36548	98
36549	102
36554	93
36555	92
36557	94
36558	102
36563	91
36564	100
36566	126
36567	88

I = interference with quantitation of surrogate.

SELECTED PESTICIDES RECOVERY

Compound*	#38538	39539 u	38538 yj
p,p'-DDT*	47 ug/Kg	88%	I
p,p'-DDE*	33 ug/Kg	101%	103%
p,p'-DDD*	31 ug/Kg	80%	80%
Endosulfan I	--	122%	125%
Alpha-BHC*	4 ug/Kg	96%	96%
Beta-BHC	--	114%	113%
Lindane	--	114%	113%
Delta-BHC	--	111%	109%
Heptachlor	--	105%	76%
PCB 1260	36 ug/Kg	39 ug/Kg	33 ug/Kg

*Values presented are collected for amounts present in spiked sample.
I = interference with quantitation of surrogate.

PRECISION OF QUANTIFIED PESTICIDES

Compound	#37504	#37504 Duplicate
p,p'-DDT	64 ug/Kg	57 ug/Kg
p,p'-DDE	92 ug/Kg	48 ug/Kg
p,p'-DDD	40 ug/Kg	16 ug/Kg
Alpha-BHC	10 ug/Kg	2 ug/Kg
Surrogate Recovery	96%	67%

Laucks
Testing Laboratories, Inc.
940 South Harney Street. Seattle, Washington 98108 (206) 767-5060
Chemistry, Microbiology, and Technical Services

Certificate

Dept. of Ecology

LABORATORY NO 87070

APPENDIX

Replicate Quality Control Report

Sample	Analyte	Replicate 1	Replicate 2	Relative Error	Control Limits
6	Total Organic Carbon	0.4	0.3	(0.1)	
7	Total Organic Carbon	1.7	1.5	12.	

A standard reference material with a TOC "true value" of 3.8 - 4.7 was analyzed in duplicate, with results as shown below:

Reference Material	Total Organic Carbon	4.4	4.0		3.8-4.7

() indicates absolute error.